AD-A104 693 HORNER AND SHIFRIN INC ST LOUIS MO F/G 13/13
NATIONAL DAM SAFETY PROGRAM. VOELKERDING LAKE DAM (MO 30059), M--ETC(U)
SEP 80 DACW43-80-C-0063

UNCLASSIFIED NL

1 OF 1
AD A
104693

END
DATE
FILMED
10-81
DTIC

LEVEL

3 MISSOURI - KANSAS CITY BASIN

AD A104693

2 VOELKERDING LAKE DAM,

4 WARREN COUNTY, MISSOURI

MO 30059

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

81 9 28 068

SEPTEMBER 1980

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A104693	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Voelkerding Lake Dam (MO 30059) Warren County, Missouri		5. TYPE OF REPORT & PERIOD COVERED Final Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Horner & Shifrin, Inc.		8. CONTRACT OR GRANT NUMBER(s) DACW43-80-C-0063
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		12. REPORT DATE September 1980
		13. NUMBER OF PAGES Approximately 50
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) National Dam Safety Program. Voelkerding Lake Dam (MO 30059), Warren County, Missouri. Phase I Inspection Report.		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

411005

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

MISSOURI - KANSAS CITY BASIN

VOELKERDING LAKE DAM

WARREN COUNTY, MISSOURI

MO 30059

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

SEPTEMBER 1980

DEPARTMENT OF THE ARMY

ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO
ATTENTION OF

LMSED-P

SUBJECT: Voelkerding Lake Dam, MO 30059

This report presents the results of field inspection and evaluation of the Voelkerding Lake Dam, MO 30059. It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY: SIGNED — 16 SEP 1980
Chief, Engineering Division — Date

APPROVED BY: SIGNED — 17 SEP 1980
Colonel, CE, District Engineer — Date

VOELKERDING LAKE DAM

MISSOURI INVENTORY NO. 30059

WARREN COUNTY, MISSOURI

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY:

HORNER & SHIFRIN, INC.
5200 OAKLAND AVENUE
ST. LOUIS, MISSOURI 63110

FOR:

U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS

SEPTEMBER 1980

HS-8011

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Voelkerding Lake Dam
State Located:	Missouri
County Located:	Warren
Stream:	Tributary of Lake Creek
Date of Inspection	20 May 1980

The Voelkerding Lake Dam was visually inspected by engineering personnel of Horner & Shifrin, Inc., Consulting Engineers, St. Louis, Missouri. The purpose of this inspection was to assess the general condition of the dam with respect to safety and, based upon this inspection and available data, determine if the dam poses a hazard to human life or property.

The following summarizes the findings of the visual inspection and the results of certain hydrologic/hydraulic investigations performed under the direction of the inspection team. Based on the visual inspection and the results of the hydrologic/hydraulic investigations, the present general condition of the dam is considered to be somewhat less than satisfactory. The following deficiencies were noticed during the inspection and are considered to have an adverse effect on the overall safety and future operation of the dam:

1. Seepage, as characterized by soft ground, running and standing water, and willow trees, was observed at the toe of the downstream slope in an area which extended from the center of the dam to the intersection of the toe of the dam and the left abutment. Uncontrolled seepage could develop into a piping condition (progressive internal erosion) that can lead to failure of the dam. Saturation of the soil adjacent to the dam can weaken the foundation and impair the stability of the dam.

2. Numerous small trees were present at the normal waterline on the upstream face of the dam. Tree roots can provide a passageway for lake seepage which could lead to a piping condition resulting in failure of the dam.

3. A 4-inch lake drain pipe is reported to be buried in the dam. The pipe could become a source of water intrusion into the embankment that could impair the stability of the dam.

According to the criteria set forth in the recommended guidelines, the magnitude of the spillway design flood for the Voelkerding Lake Dam, which is classified as small in size and of high hazard potential, is specified to be a minimum of one-half the Probable Maximum Flood (PMF). The Probable Maximum Flood (PMF) is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. Considering the fact that a fairly large volume of water is impounded and that numerous dwellings, including portions of the Town of Dutzow, lie within the possible flood damage zone, it is recommended that the spillway for this dam be designed for the PMF. The PMF is ordinarily accepted as the inflow design flood for dams where failure of the structure would increase the danger to human life.

Results of a hydrologic/hydraulic analysis indicated that the spillways, principal plus emergency, are inadequate to pass lake outflow resulting from a storm of PMF magnitude. The spillways are capable of passing lake outflow corresponding to about 55 percent of the PMF lake inflow and the lake outflow resulting from the 1 percent chance (100-year frequency) flood. According to the St. Louis District, Corps of Engineers, the length of the downstream damage zone, should failure of the dam occur, is estimated to be one mile. Accordingly, within the possible damage zone are a highway department maintenance building, three dwellings, a building, and about twenty-four other buildings and dwellings which are located within the Town of Dutzow.

A review of available data did not disclose that seepage or stability analyses of the dam were performed. This is considered a deficiency and should be rectified.

It is recommended that the Owner take the necessary action in the near future to correct or control the deficiencies and safety defects reported herein.

Ralph E. Sauthoff

Ralph E. Sauthoff
P. E. Missouri E-19090

Albert B. Becker, Jr.

Albert B. Becker, Jr.
P.E. Missouri E-9168

OVERVIEW VOELKERDING LAKE DAM

PHASE 1 INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

VOELKERDING LAKE DAM - MO 30059

TABLE OF CONTENTS

LIST OF PLATES AND CHARTS

APPENDIX A - INSPECTION PHOTOGRAPHS

APPENDIX B - HYDROLOGIC AND HYDRAULIC ANALYSES

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

VOELKERDING LAKE DAM - MO 30059

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, dated 8 August 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, directed that a safety inspection of the Voelkerding Lake Dam be made.

b. Purpose of Inspection. The purpose of this visual inspection was to make an assessment of the general condition of the dam with respect to safety and, based upon available data and this inspection, determine if the dam poses a hazard to human life or property.

c. Evaluation Criteria. This evaluation was performed in accordance with the "Phase I" investigation procedures as prescribed in "Recommended Guidelines for Safety Inspection of Dams", Appendix D to "Report to the Chief of Engineers on the National Program of Inspection of Non-Federal Dams", dated May 1975.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances. The Voelkerding Lake Dam is an earthfill type embankment rising approximately 35 feet above the natural streambed at the downstream toe of the barrier. The embankment has an upstream slope of approximately 1v on 3.8h, a crest width of about 11 feet,

and a downstream slope on the order of 1v on 3.3h. The length of the dam is approximately 400 feet. A plan and profile of the dam are shown on Plate 3 and a cross-section of the dam is shown on Plate 4. At normal pool elevation the reservoir impounded by the dam occupies approximately 14 acres. There is no drawdown facility to dewater the lake.

The dam has both a principal and an emergency spillway. The principal spillway, an excavated earth section, is located at the right, or south, abutment. The principal spillway has two outlets located approximately 90 feet downstream of the crest. A 15-inch corrugated metal pipe discharges flow from the spillway channel through an earthen embankment. Flow from the pipe follows an unimproved channel approximately 100 feet to join the original stream on which the dam is constructed. The second outlet, which is approximately 2.4 feet higher in elevation than the invert of the 15-inch pipe, is an excavated trapezoidal channel. The channel for this outlet is about 160 feet in length. Lake outflow greater than the capacity of the 15-inch pipe is released via the channel outlet.

The emergency spillway, an earthen trapezoidal section, is located at the left or north abutment. It appears that flow from this outlet will follow near the toe of the dam in order to reach the original stream channel beyond the dam. Cross-sections of the principal spillway outlet channel and the emergency spillway are shown on Plate 5.

b. Location. The dam is located on an unnamed tributary of Lake Creek, about 0.1 mile west of Highway TT and approximately 0.4 mile northeast of the Town of Dutzow, Missouri, as shown on the Regional Vicinity Map, Plate 1. The dam is located in Section 35, Township 45 North, Range 1 West, within Warren County.

c. Size Classification. The size classification based on the height of the dam and storage capacity, is categorized as small (per Table 1, Recommended Guidelines for Safety Inspection of Dams).

d. Hazard Classification. The Voelkerding Lake Dam, according to the St. Louis District, Corps of Engineers, has a high hazard potential, meaning

that if the dam should fail, there may be loss of life, serious damage to homes, or extensive damage to agricultural, industrial and commercial facilities, important public utilities, main highways, or railroads. The estimated flood damage zone, should, failure of the dam occur, as determined by the St. Louis District, extends one mile downstream of the dam. Within the possible damage zone are a highway department maintenance building, three dwellings, a building, and about twenty-four other dwellings and buildings which are located within the Town of Dutzow. Those features lying within the downstream damage zone reported by the Corps of Engineers, St. Louis District, were verified by the inspection team.

e. Ownership. The lake and dam are owned by the Walter and Jean Voelkerding Charitable Trust. One of the managers of the Trust is Mr. David Voelkerding. Mr. Voelkerding's address is Rural Route 2, Marthasville, Missouri 63357.

f. Purpose of Dam. The dam impounds water for recreational use.

g. Design and Construction History. According to Mr. Harry Bratton, a neighbor and former employee of the original owner, the dam was constructed in about 1960 by Mr. Walter Voelkerding and his farm help. Walter Voelkerding, deceased, was the owner of the property at the time the dam was constructed. The extent of the engineering investigations performed for design of the dam is unknown.

h. Normal Operational Procedure. The lake level is unregulated. Lake outflow is governed by the capacities of the principal and emergency spillways.

1.3 PERTINENT DATA

a. Drainage Area. Approximately one-half of the area tributary to the lake is in a native state covered with timber. The remainder of the drainage area is for the most part farmland. The watershed above the dam amounts to approximately 97 acres. The watershed area is outlined on Plate 2.

b. Discharge at Damsite.

(1) Estimated known maximum flood at damsite ... 16 cfs* (W.S.Elev.534.7)

(2) Spillway capacity

a. Principal ... 86 cfs (W. S. Elev. 535.7)

b. Principal + emergency ... 458 cfs (W. S. Elev. 537.2)

c. Elevation (Ft. above MSL). The following elevations were determined by survey and are based on the elevation of the lake, assumed to be normal pool, as shown on the 1972 Washington East, Missouri, Quadrangle Map, 7.5 Minute Series.

(1) Observed pool ... 533.9

(2) Normal pool ... 534.0

(3) Spillway crest

a. Principal ... 534.0

b. Emergency ... 535.7

(4) Maximum experienced pool ... 534.7*

(5) Top of Dam ... 537.2 (min.)

(6) Streambed at centerline of dam ... 503± (est.)

(7) Maximum tailwater ... Unknown

(8) Observed tailwater ... None

d. Reservoir.

(1) Length at normal pool (Elev. 534.0) ... 1,500 ft.

(2) Length at maximum pool (Elev. 537.2) ... 1,600 ft.

e. Storage.

(1) Normal pool ... 145 ac. ft.

(2) Top of dam (incremental) ... 55 ac. ft.

* Based on an estimate of lake level as observed by Mr. Harry Bratton, a neighbor and former employee of the original owner.

f. Reservoir Surface.

(1) Normal pool ... 14 acres

(2) Top of dam (incremental) ... 8 acres

g. Dam. The height of the dam is defined to be the overall vertical distance from the lowest point of foundation surface at the downstream toe of the barrier, to the top of the dam.

(1) Type ... Earthfill, core wall*

(2) Length ... 400 ft.

(3) Height ... 35 ft.

(4) Top width ... 11 ft.

(5) Side slopes

a. Upstream ... 1v on 3.8h (above waterline)

b. Downstream ... 1v on 3.3h

(6) Cutoff ... Core trench*

(7) Slope protection

a. Upstream ... Stone riprap

b. Downstream ... Grass

h. Principal Spillway.

(1) Type ... Uncontrolled, excavated earth, trapezoidal section

(2) Location ... Right abutment

(3) Elevation ... 534.0

(4) Approach channel ... Lake

(5) Outlets

a. Pipe

1. Description ... 15-inch diameter corrugated metal pipe

2. Invert ... Elevation 531.8

b. Channel

1. Description ... Excavated earth, trapezoidal section, length 160 feet

2. Crest ... Elevation 534.2

* Per Mr. Harry Bratton.

i. Emergency Spillway.

(1) Type ... Uncontrolled, excavated earth, trapezoidal section

(2) Location ... Left abutment

(3) Crest ... Elevation 535.7

(4) Approach channel ... Lake

(5) Exit channel ... Unconfined, earth (unimproved)

j. Lake Drawdown Facility ... None

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No engineering data relating to the design of the dam are known to exist.

2.2 CONSTRUCTION

No formal records were maintained during construction of the dam. As previously stated, Voelkerding Lake Dam was constructed in about 1960 by Mr. Walter Voelkerding and his farm help. An interview with Mr. Harry Bratton, who was employed by the former owner and aided in construction of the dam. indicated that a core trench approximately 10 feet wide, was excavated about 8 feet deep to reach what was considered to be the more impervious material. Mr. Bratton reported that fill for the dam was obtained from the area now occupied by the lake, and was compacted with the farm type equipment used to construct the dam.

2.3 OPERATION

The lake level is uncontrolled and governed by the elevation of the crest of the principal spillway. An emergency spillway with a crest elevation approximately 1.7 feet higher than the crest of the principal spillway and about 1.5 feet lower than the top of the dam at its lowest point, also serves as an outlet for lake surcharge. No indication was found that the dam has been overtopped. Mr. Harry Bratton, who presently resides near the lake, reported that the dam has never been overtopped and that the highest lake level observed was approximately 0.7 foot higher than the normal level.

Mr. Bratton also indicated that a 4-inch drain pipe which was installed through the original dam is no longer serviceable due to the fact that the downstream end of the pipe was covered with earth when additional fill, as discussed in Section 6.1d, was placed on the slope in about 1976.

Although seepage was not mentioned as being a problem by either the Owner or Mr. Bratton, a geologic reconnaissance report indicates that the dam did experience considerable leakage at one time. The report, dated August 19, 1966, reference Chart 2-1, was prepared by Mr. Edwin E. Lutzen, Engineering Geologist, with the Missouri Geological Survey. In the report Mr. Lutzen (deceased), describes various methods of correcting the dam leakage. However, no additional information was available regarding the seepage or any modifications to the dam which may have been made to alleviate the condition.

2.4 EVALUATION

a. Availability. Engineering data for assessing the design of the dam and spillways were unavailable.

b. Adequacy. No data available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the Voelkerding Lake Dam was made by Horner & Shifrin engineering personnel, R. E. Sauthoff, Civil Engineer, and A. B. Becker, Jr., Civil and Soils Engineer, on 20 May 1980. An examination of the dam area was also made by an engineering geologist, Jerry D. Higgins, Ph.D., a consultant retained by Horner & Shifrin for the purpose of assessing the site geology. Also examined at the time of the inspection, were the areas and features below the dam within the potential flood damage zone. Photographs of the dam taken at the time of the inspection are included on Pages A-1 through A-5 of Appendix A. The locations of the photographs taken during the inspection are indicated on Plate 3.

b. Site Geology. The topography at the dam site is gently rolling, becoming more rugged within the drainage basin to the north of the reservoir. The relief between the reservoir and the drainage divide, one-quarter mile north, is approximately 190 feet. The site is located within the Salem Plateau Section of the Ozark Plateaus Physiographic Province, near its border with the Dissected Till Plains Section of the Central Lowlands Province.

The bedrock formations consist of gently northward-dipping Ordovician-age sedimentary strata of the Jefferson City-Cotter and the St. Peter formations. The dam and reservoir are located entirely on the Jefferson City-Cotter, and much of the drainage basin is underlain by the St. Peter. Exposures of the base of the St. Peter formation were located approximately 10 feet above the reservoir. No faulting was observed or reported in the vicinity of the dam site.

The Jefferson City-Cotter formation is a light brown, medium to finely crystalline dolomite. It is thin- to medium-bedded, often argillaceous, and cherty. Solution enlargement of joints and bedding planes frequently occurs, and the contact between the bedrock and the residuum, formed by the in-place weathering of the dolomites, is often an irregular surface. The St. Peter

formation is a white, fine- to medium-grained pure quartz sandstone. It generally is massively bedded and, although loosely cemented, exposed rock surfaces are usually case-hardened by weathering processes.

The unconsolidated surficial materials in the vicinity of the reservoir are composed principally of soils derived from loessal deposits and colluvium. The dam site and reservoir are underlain by soils of the Winfield series; the upland drainage basin by the Holstein series. The Winfield series consists of deep, well-drained soils formed in loess and the underlying residuum. They typically consist of a light brown silt in the upper layers, becoming darker and more clayey with depth. According to the Unified Soil Classification System the soils are classified as CL or CL-ML materials, are moderately permeable, but are generally suited for small embankments and water impoundments. These soils are easily eroded if slopes are unprotected. The Holstein soils have been formed from a combination of the silts and colluvial materials derived from weathering of bedrock. They have been formed at the foot of hill slopes; thus the soils vary from SC near St. Peter sandstone outcrops to CL-ML materials where there is a higher percentage of loessal materials. The Holstein soils are moderately permeable, subject to seepage, and easily eroded on slopes.

The loessal soils at the dam site are thick with bedrock exposures limited to a few gulleys upstream from the reservoir. No slumping or severe erosion was noted at the embankment. A number of deep gulleys and associated slumping were noted in the loessal soils around the drainage basin, but these gulleys in no way affect the stability of the embankment. However, the gulleying illustrates the erodibility of the soils from which the embankment is constructed. It is reported that the reservoir has experienced considerable leakage through sandy soils underneath the reservoir and embankment. These soils were uncovered during construction of the dam and were probably derived from the St. Peter sandstone formation.

The most significant geologic conditions at the site are the easily eroded loessal soils and the sandy residual soils reported to be present under the dam. No other adverse geologic conditions were observed that would be considered conducive to severe reservoir leakage or embankment instability.

c. Dam. The visible portions of the upstream and downstream faces of the dam (see Photos 1 and 2) were examined and appeared to be in sound condition. The dam, with the exception of the crest and the riprap protected areas of the upstream face, was covered with fescue grass which for the most part was about 24 inches high at the time of the inspection. The turf cover on the crest of the dam, however, was sparse in some areas and numerous small, random, interconnected cracks which were a maximum of about 1/4 inch wide and 6 inches deep were noticed in those areas. No other cracking, sloughing of the embankment or settlement of the dam crest was evident. An examination of the surficial material obtained from the downstream face of the dam indicated it to be a silty lean clay (CL) of low-to-medium plasticity. Riprap consisting of crushed limestone with a maximum size of about 6 inches extended approximately 2 feet above the normal waterline along the upstream face of the dam. Numerous willow trees up to 2 inches in diameter were present along the upstream face of the dam near the normal waterline and a V-shaped channel about 2 feet deep had been eroded into the downstream slope of the embankment near the right abutment apparently by stormwater runoff.

An area of seepage (see Photos 9 and 10) with willow trees, soft ground, and standing and flowing water, was observed near the toe of the downstream slope extending from the center of the dam to the junction of the toe of the dam and the left abutment. Flow from the area appeared clear and was estimated to be less than 2 gpm.

The principal spillway channel (see Photos 3 and 4) was well covered with fescue grass about 24 inches high along with some brush and small trees. The visible portions of the 15-inch corrugated metal spillway outlet pipe (see Photos 5 and 6) were examined and appeared to be in sound condition. Scour, apparently by high velocity pipe discharges, has created a bowl-shaped depression approximately 10 feet wide and 6 feet deep at the downstream end of the spillway outlet pipe. The principal spillway outlet channel (see Photo 7), an excavated earth section, was thoroughly covered with fescue grass. Several small trees were also found within the channel.

The emergency spillway (see Photo 8) which is located at the left abutment also appeared to be in satisfactory condition. Some small willow trees were observed along the waterline at the lake approach to the spillway. The outlet channel for the emergency spillway was unimproved. It appeared that spillway releases will follow along the toe of the dam in order to reach the downstream channel.

d. Downstream Channel. Except at the road and rail crossings the channel downstream of the dam is unimproved. Near the dam, the channel for the most part was grass covered with trees growing along the banks. The channel crosses Highway TT at a point about 1,000 feet downstream of the dam and joins Lake Creek approximately 1,500 feet downstream of the dam. Lake Creek crosses Highway 94 approximately 3,500 feet downstream of the dam and railroad tracks belonging to the Missouri-Kansas-Texas Railroad at a point about 1 mile downstream of the dam. The Town of Dutzow lies just to the west of Lake Creek at the Highway 94 crossing.

e. Reservoir. The lake shoreline is either grass covered or tree lined. At the time of the inspection the lake was near normal pool level and the water within the reservoir was clear. No significant erosion of the lake banks was noted. The amount of sediment within the lake could not be determined at the time of the inspection: however, due to the vegetation covering the surrounding area, it is not expected to be significant.

3.2 EVALUATION

The deficiencies observed during this inspection and noted herein are not considered of significant importance to warrant immediate remedial action.

The limestone riprap on the upstream face of the dam appears to be adequate to prevent erosion of the slope by wave action or fluctuations of the lake level.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The spillways are uncontrolled. The lake surface level is governed by precipitation runoff, evaporation, seepage, and the capacities of the uncontrolled principal and emergency spillways.

4.2 MAINTENANCE OF DAM

Judging by their appearance, the embankment and areas immediately adjacent thereto seem to receive periodic maintenance. Apparently, trees and brush are not regularly removed from the upstream face of the dam or from the spillway channels since their presence was noted during the inspection. It was also noticed during the inspection that no provisions have been taken to control the seepage that is occurring at the left side of the dam.

4.3 MAINTENANCE OF OUTLET OPERATING FACILITIES

No outlet facilties requiring operation exist at this dam, and there is no reservoir regulation place.

4.4 DESCRIPTION OF ANY WARNING SYSTEMS IN EFFECT

The inspection did not reveal the existence of a dam failure warning system.

4.5 EVALUATION

Lack of or inadequate maintenance is considered detrimental to the safety of the dam. It is recommended that maintenance of the dam and spillways be undertaken on a regular basis and that records be kept of all major items of work performed. It is also recommended that a detailed inspection of the dam be instituted on a regular basis by an engineer experienced in the design and construction of dams and that records be kept of all inspections made and remedial measures taken.

SECTION 5 - HYDROLOGIC/HYDRAULIC

5.1 EVALUATION OF FEATURES

a. Design Data. Design data are not available.

b. Experience Data. The drainage area and lake surface area were developed from the 1972 USGS Washington East, Missouri, Quadrangle Map. The proportions and dimensions of the spillways and dam were developed from surveys made during the inspection. Records of rainfall, streamflow or flood data for the watershed were not available.

According to the St. Louis District, Corps of Engineers, the estimated flood damage zone, should failure of the dam occur, extends one mile downstream of the dam. Portions of the Town of Dutzow are within the potential flood damage zone.

c. Visual Observations.

(1) The principal spillway which is located at the right abutment has a shallow, trapezoidal crest section. This spillway has two outlets which consist of the following:

(a) A 15-inch corrugated metal spillway pipe.

(b) A shallow, excavated earth, broad-crested trapezoidal section.

(2) The 15-inch pipe provides an outlet for normal, service-type, lake outflow. The channel provides an outlet for lake outflow in excess of the capacity of the 15-inch pipe.

(3) The emergency spillway is a shallow broad-crested trapezoidal section, is located at the left abutment.

(4) The original stream channel abuts the toe of the dam.

d. Overtopping Potential. The spillways (principal and emergency) are inadequate to pass the probable maximum flood without overtopping the dam. The spillways are adequate, however, to pass 1/2 the probable maximum flood without overtopping the dam. The results of the dam overtopping analysis are as follows:

(Note: The data appearing in the following table have been extracted from the computer output data appearing in Appendix B. Decimal values have been rounded to the nearest one-tenth in order to prevent assumption of unwarranted accuracy.)

Ratio of PMF	Q-Peak Outflow (cfs)	Max. Lake W.S. Elev.	Max. Depth (Ft.) of Flow over Dam (Elev. 537.2)	Duration of Overtopping of Dam (Hrs.)
0.50	396	537.0	0	0
1.00	1,439	538.1	0.9	1.2

Elevation 537.2 was found to be the lowest point in the dam crest. The flow safely passing the spillway just prior to overtopping amounts to approximately 458 cfs, which is the routed outflow corresponding to about 55 percent of the probable maximum flood inflow. During peak flow of the probable maximum flood, the greatest depth of flow over the dam is projected to be 0.9 feet and overtopping will extend across the entire length of the dam.

e. Evaluation. Experience with embankments constructed of similar material (a silty lean clay of low-to-medium plasticity) to that used to construct this dam has shown evidence that the material under certain conditions, such as high velocity flow, can be very erodible. Such a condition exists during the PMF when large lake outflow, accompanied by high flow velocities, occurs. For the PMF condition, a certain amount of damage by erosion to the crest and downstream face of the dam is expected. However, since the depth of flow over the dam crest, a maximum of 0.9 feet, and the

duration of flow over the dam, 1.2 hours, are considered to be relatively minor, and since the downstream face and for the most part the dam crest, are protected by a substantial cover of grass, failure of the dam by erosion during overtopping is not expected.

f. Reference. Procedures and data for determining the probable maximum flood, the 100-year frequency flood, and the discharge rating curves for flow passing the spillways and dam crest are presented on Pages B-1 through B-3 of the Appendix. Listings of the HEC-1 (Dam Safety Version) input data for both the probable maximum flood and the 100-year freqency flood are shown on pages B-4 through B-6. Computer output data, including unit hydrograph ordinates, tabulation of PMF rainfall, loss and inflow data are shown on pages B-7 through B-11; tabulation of lake surface area, elevation and storage volume is shown on page B-12 and tabulations titled "Summary of Dam Safety Analysis" for the PMF and 1 percent chance (100-year frequency) flood are also shown on page B-12.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations of conditions which adversely affect the structural stability of the dam are discussed in Section 3, paragraph 3.1c.

b. Design and Construction Data. No design or construction data relating to the structural stability of the dam are known to exist. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Operating Records. No appurtenant structures or facilities requiring operation exist at this dam. According to Mr. David Voelkerding, Trustee, no records are kept of the lake level, spillway discharge, dam settlement, or seepage.

d. Post Construction Changes. According to Mr. David Voelkerding, additional fill was placed on the downstream slope of the dam in about 1976 in order to provide the dam with greater stability. The Contractor for the work, Aholt & Sons Excavating Inc., of Augusta, Missouri, also placed riprap on the upstream face of the dam at this same time. Mr. Harry Bratton, who resides near the lake, indicated that the fill placed in 1976 extends from the dam crest to a point approximately 25 feet downstream of the toe of the original embankment. Mr. Bratton also reported that the original dam embankment had a 4-inch steel pipe drain extending through it, but that the downstream end of the drain was covered by the new fill and is no longer serviceable.

e. Seismic Stability. The dam is located in an area close to the boundary separating the Zone I and Zone II seismic probability areas. An earthquake of the magnitude that might occur in this area would not be

expected to cause structural damage to a well constructed earth dam of this size provided that static stability conditions are satisfactory and conventional safety margins exist. However, it is recommended that the prescribed seismic loading be applied in any stability analyses performed for this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. A hydraulic analysis indicated that the spillways (principal plus emergency) are capable of passing lake outflow of about 458 cfs without the level of the lake exceeding the low point in the top of the dam. A hydrologic analysis of the lake watershed area, as discussed in Section 5, paragraph 5.1d, indicates that for storm runoff of probable maximum flood magnitude, the lake outflow would be about 1,439 cfs, and that for the 1 percent chance (100-year frequency) flood, the lake outflow would be about 51 cfs.

Seepage and stability analyses of the dam were not available for review, and therefore, no judgment could be made with respect to the structural stability of the dam.

Two items were noticed during the inspection that could adversely affect the safety of the dam. These items include seepage and numerous small trees on the upstream face of the embankment.

b. Adequacy of Information. Due to lack of design and construction data, the assessments reported herein were based on external conditions as determined during the visual inspection. The assessments of the hydrology of the watershed and capacities of the spillways were based on a hydrologic/hydraulic study as indicated in Section 5. Seepage and stability analyses comparable to the requirements of "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency. The remedial measures recommended in paragraph 7.2 for the items concerning the safety of the dam noted in paragraph 7.1a should be accomplished in the near future.

d. Necessity for Phase II. Based on the results of the Phase I inspection, a Phase II investigation is not recommended.

e. Seismic Stability. The dam is located in an area close to the boundary separating the Zone I and Zone II seismic probability areas. An earthquake of the magnitude that might occur in this area would not be expected to cause structural damage to a well constructed earth dam of this size provided that static stability conditions are satisfactory and conventional safety margins exist. However, it is recommended that the prescribed seismic loading be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES

a. Recommendations. The following actions are recommended:

(1) Based upon criteria set forth in the recommended guidelines, spillway size and/or height of dam should be increased in order to pass lake outflow resulting from a storm of probable maximum flood magnitude. In either case, the spillway should be protected to prevent erosion.

(2) Obtain the necessary soil data and perform dam seepage and stability analyses in order to determine the structural stability of the dam for all operational conditions. Seepage and stability analyses should be performed by a qualified professional engineer experienced in the design and construction of earthen dams.

b. Operations and Maintenance (O & M) Procedures. The following O & M Procedures are recommended:

(1) Provide some means of controlling seepage evident in the area adjacent to the downstream toe to the left of the center of the dam. Uncontrolled seepage can lead to a piping condition (progressive internal erosion) which could result in the failure of the dam. Drainage of the areas affected by seepage should be one of the objectives of the seepage control measures since saturation of the soil weakens the foundation which could impair the stability of the dam.

(2) Remove the trees from the upstream face of the dam. Tree roots can provide a passageway for lake seepage which could lead to a piping condition and subsequent failure of the dam. The turf cover should be restored if destroyed or missing. Maintain the turf cover on the slopes at a height that will not hinder inspection of the slope or provide cover for burrowing animals.

(3) The presence of the 4-inch steel drain pipe covered by fill in 1976 could be a source of water intrusion into the embankment which could impair the stability of the dam. The Owner should address this possibility and take appropriate action.

(4) Provide maintenance of all areas of the dam and spillways on a regularly scheduled basis in order to insure features of being in satisfactory operational condition.

(5) A detailed inspection of the dam should be instituted on a regular basis by an engineer experienced in the design and construction of dams. It is also recommended, for future reference, that records be kept of all inspections made and remedial measures taken.

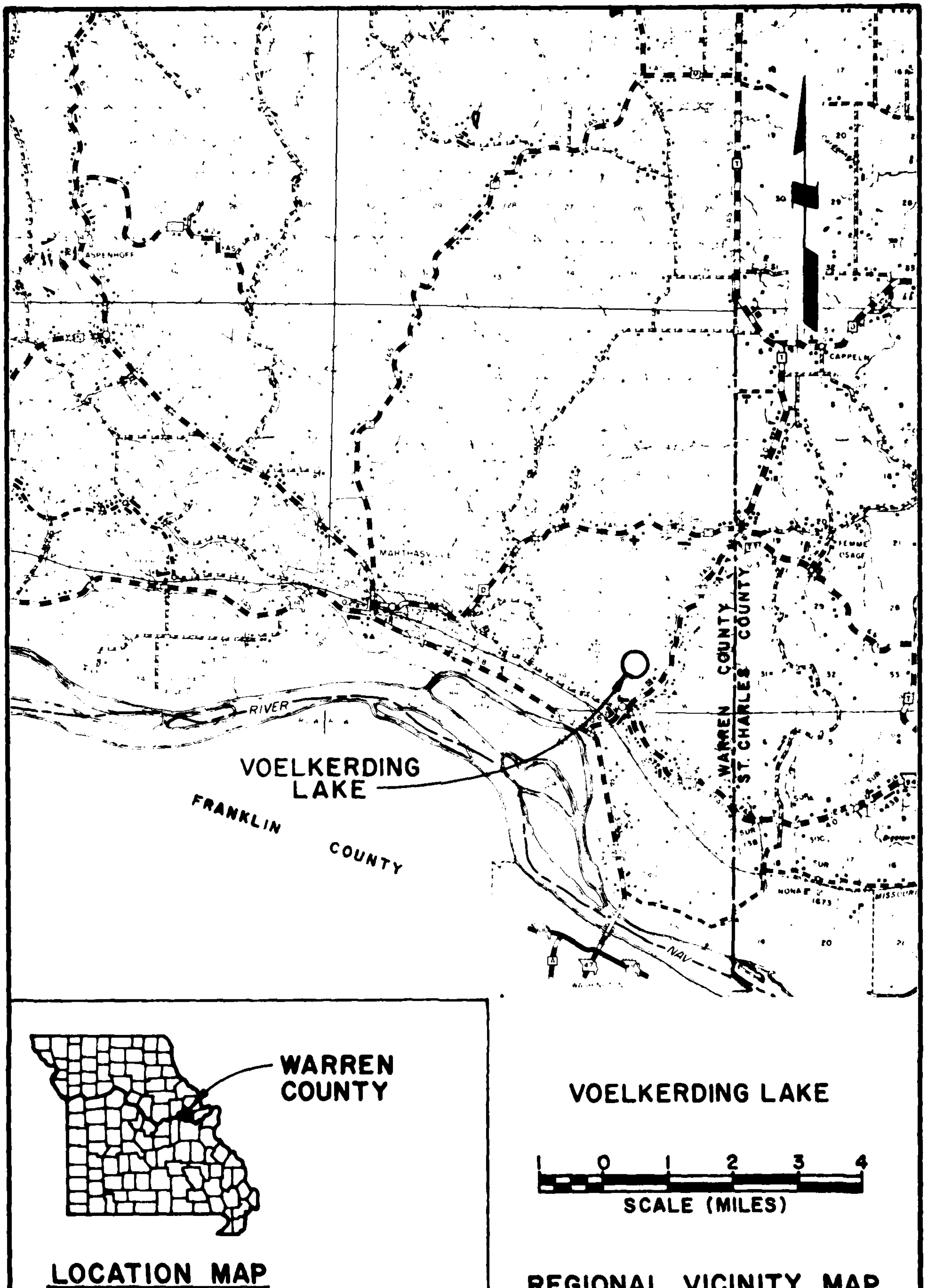
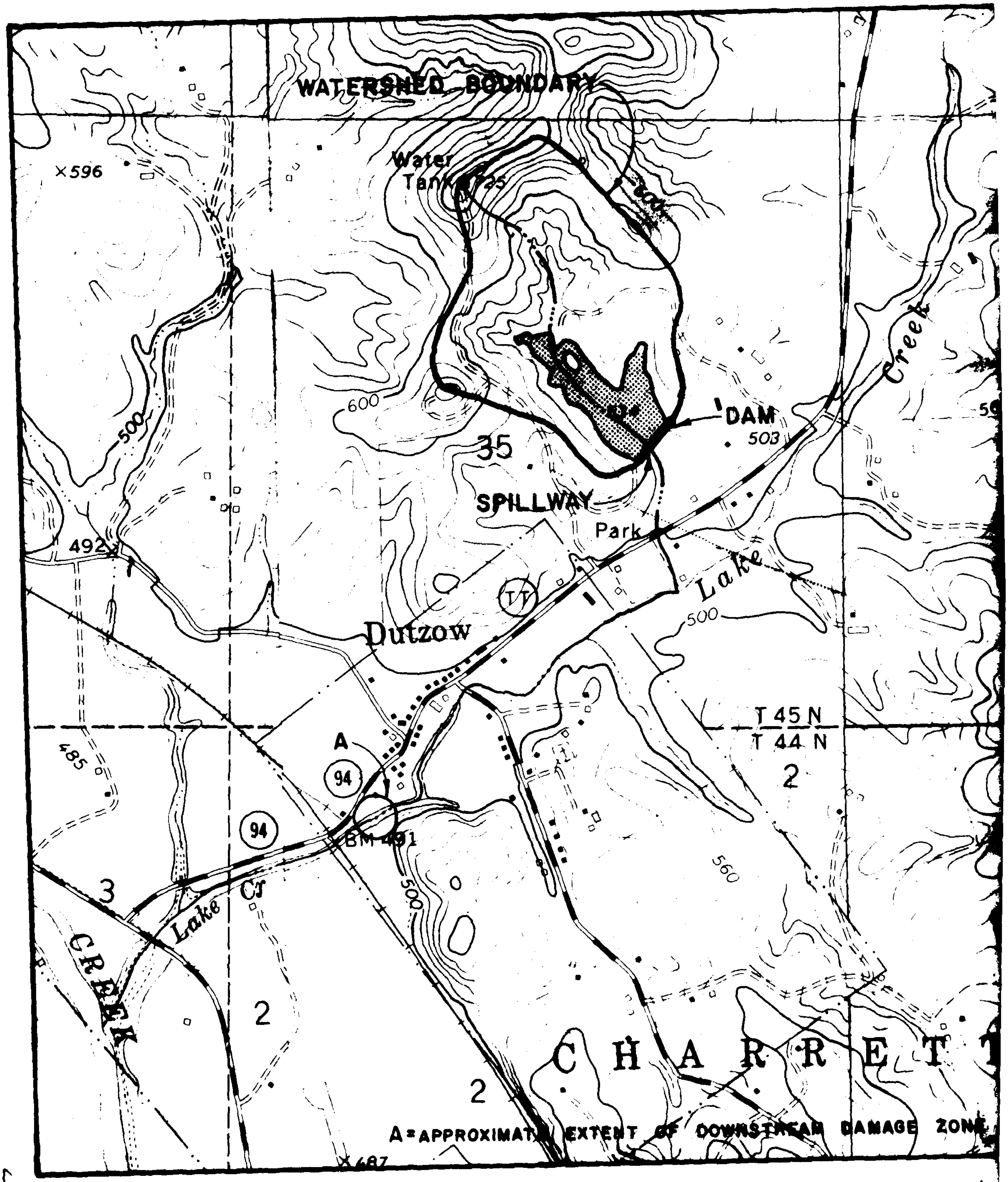
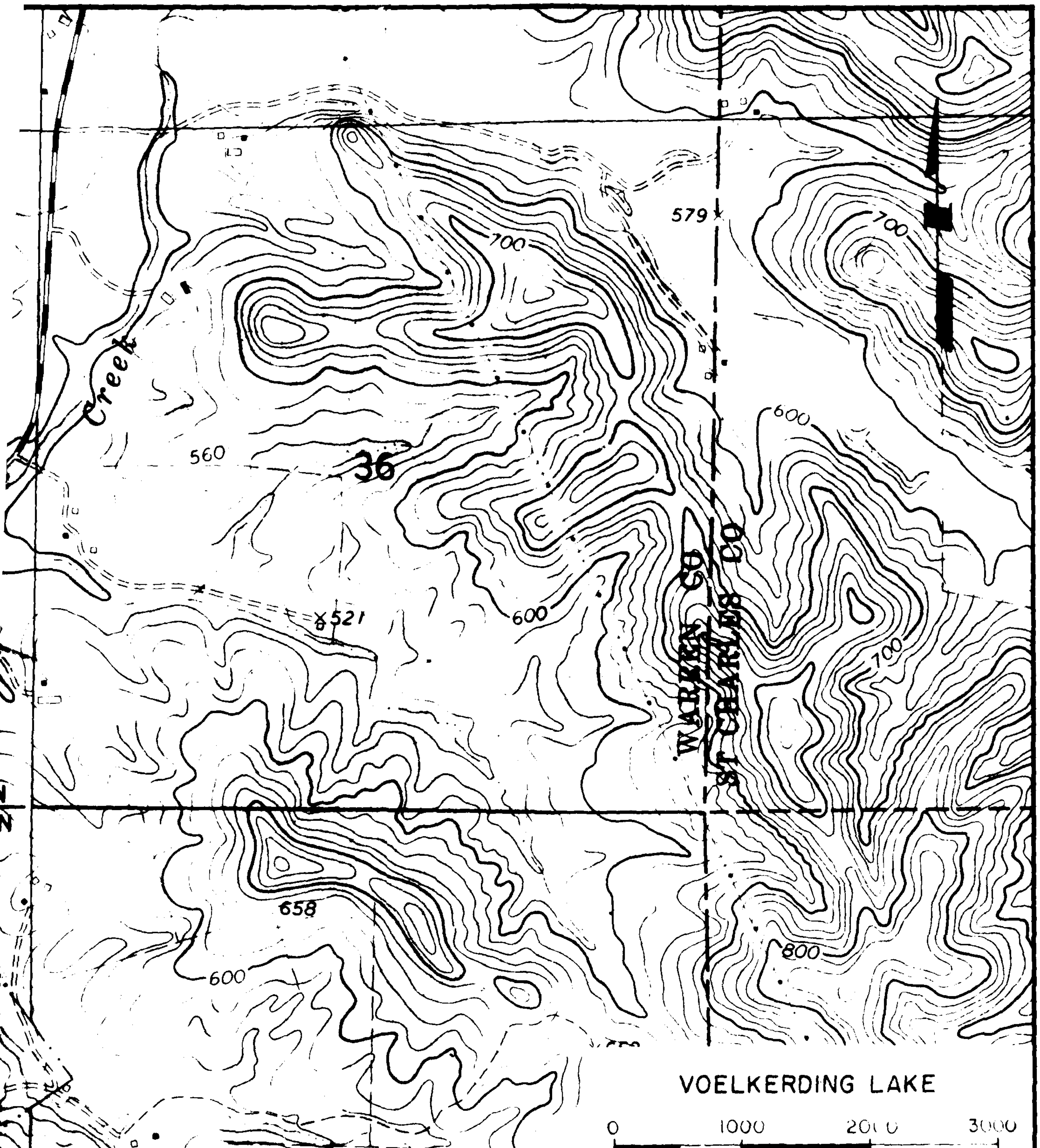

VOELKERDING
LAKE
FRANKLIN
COUNTY
RIVER
MARTHASVILLE
ASPENHOFF
WARREN COUNTY
ST CHARLES COUNTY
WARREN
COUNTY
LOCATION MAP
VOELKERDING LAKE
0 1 2 3 4
SCALE (MILES)
REGIONAL VICINITY MAP

PLATE I

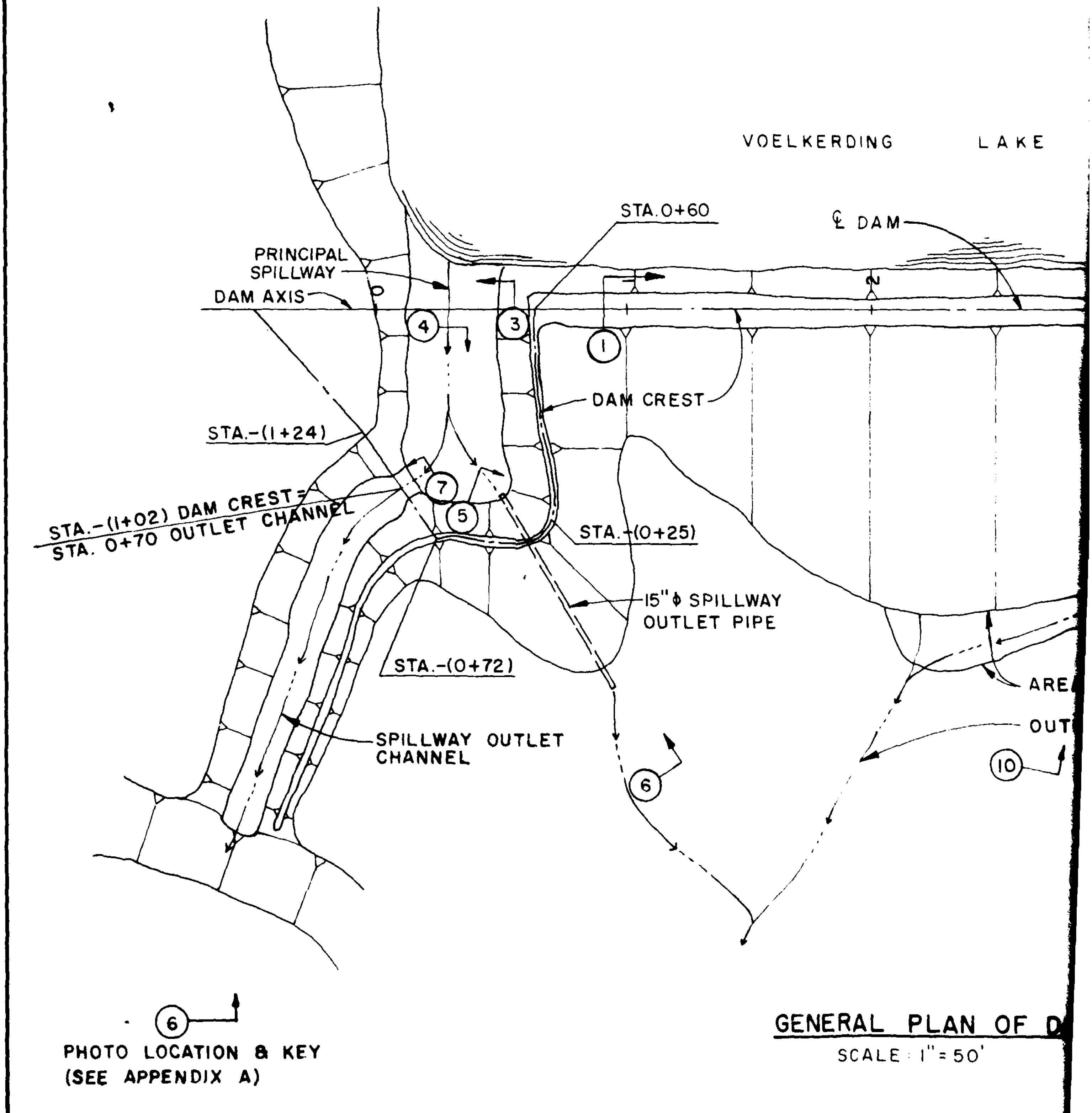


WATERSHED BOUNDARY
×596
Water
Tank
DAM
503
600
500
35
SPILLWAY
Park
492
Lake
Creek
500
Dutzow
T 45 N
T 44 N
A
94
94
485
BM 491
2
560
3
Lake Cr
CREEK
500
2
2
C H A R R E T T
A = APPROXIMATE EXTENT OF DOWNSTREAM DAMAGE ZONE
×487



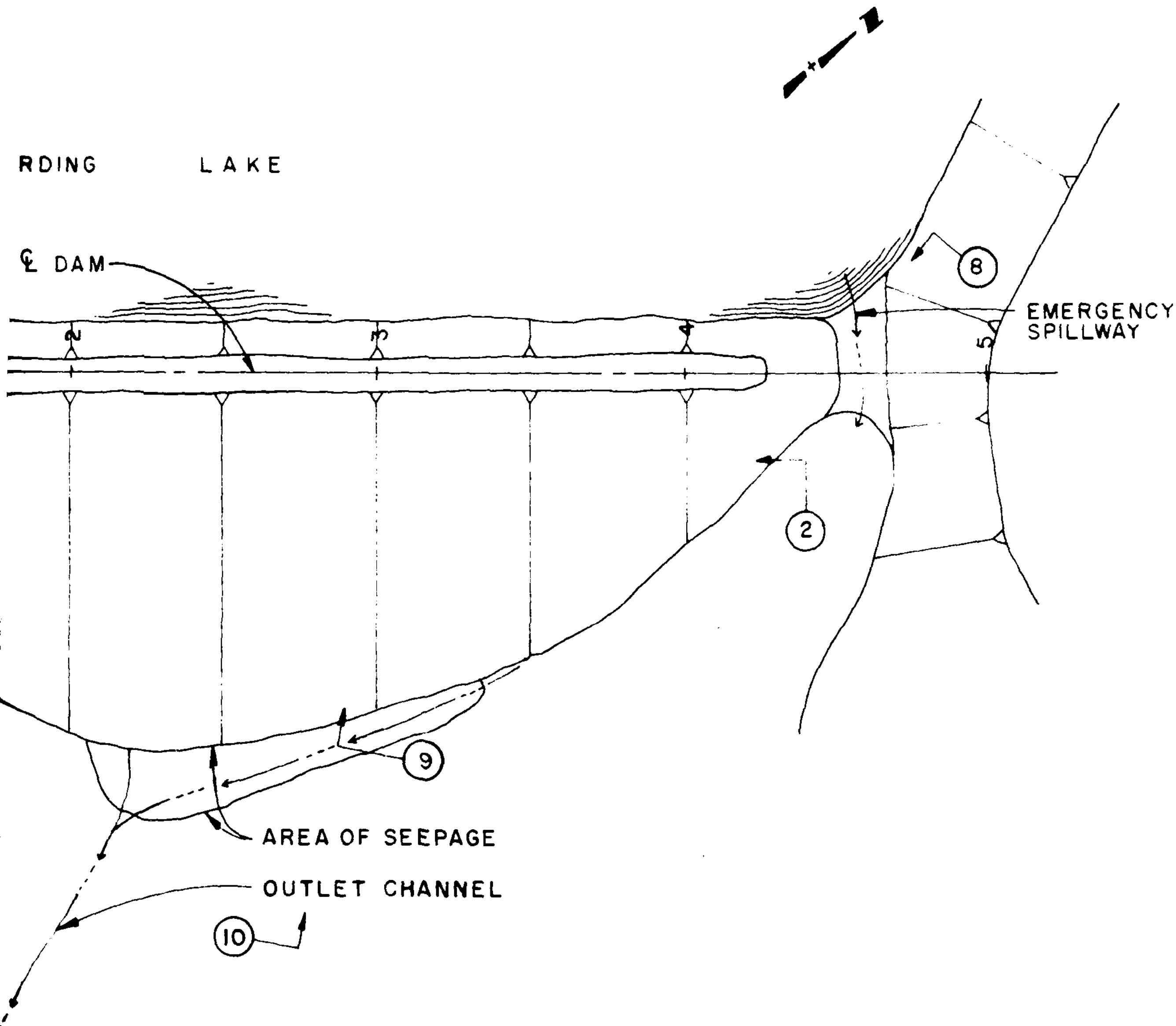
Creek
560
36
700
579
600
521
WARREN CO
ST CHARLES CO
658
800
E T T E
1
DAMAGE ZONE
VOELKERDING LAKE
0
1000
2000
3000
SCALE IN FEET
(CONTOUR INTERVAL 20 FEET)
LAKE WATERSHED MAP

PLATE 2



GENERAL PLAN OF D

SCALE: 1" = 50'



ERAL PLAN OF DAM

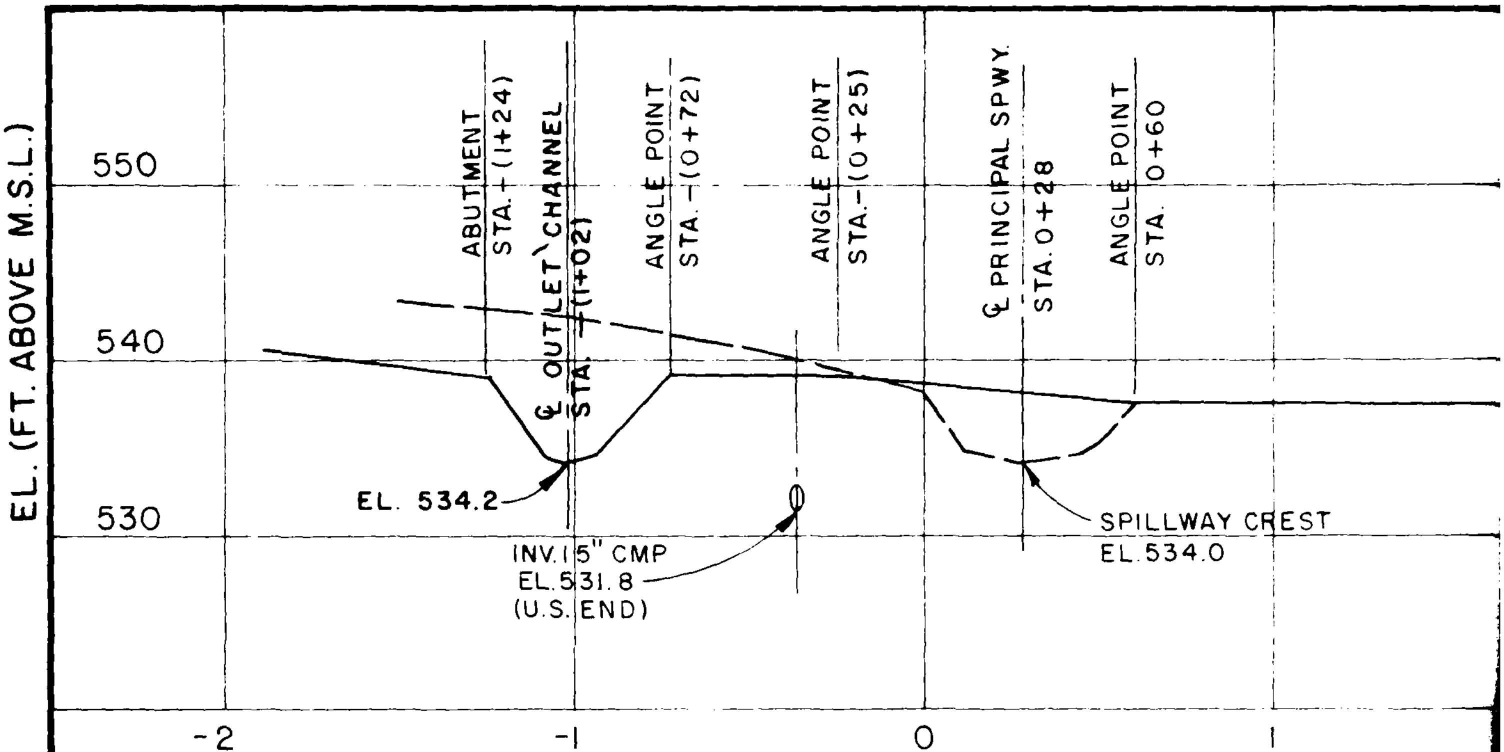
SCALE: 1"=50'

VOELKERDING LAKE
PLAN OF DAM

Horner & Shifrin, Inc. July 1980

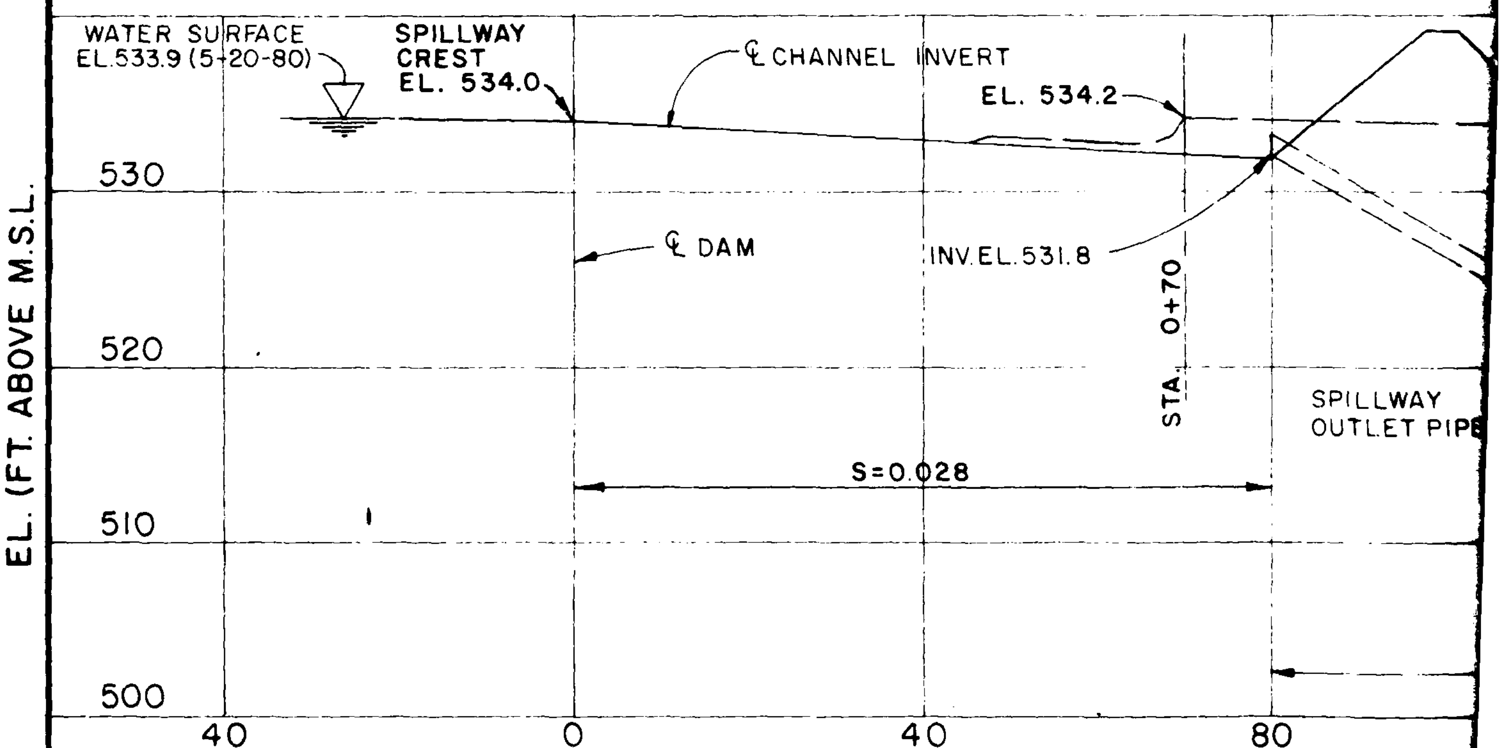
PLATE 3

12



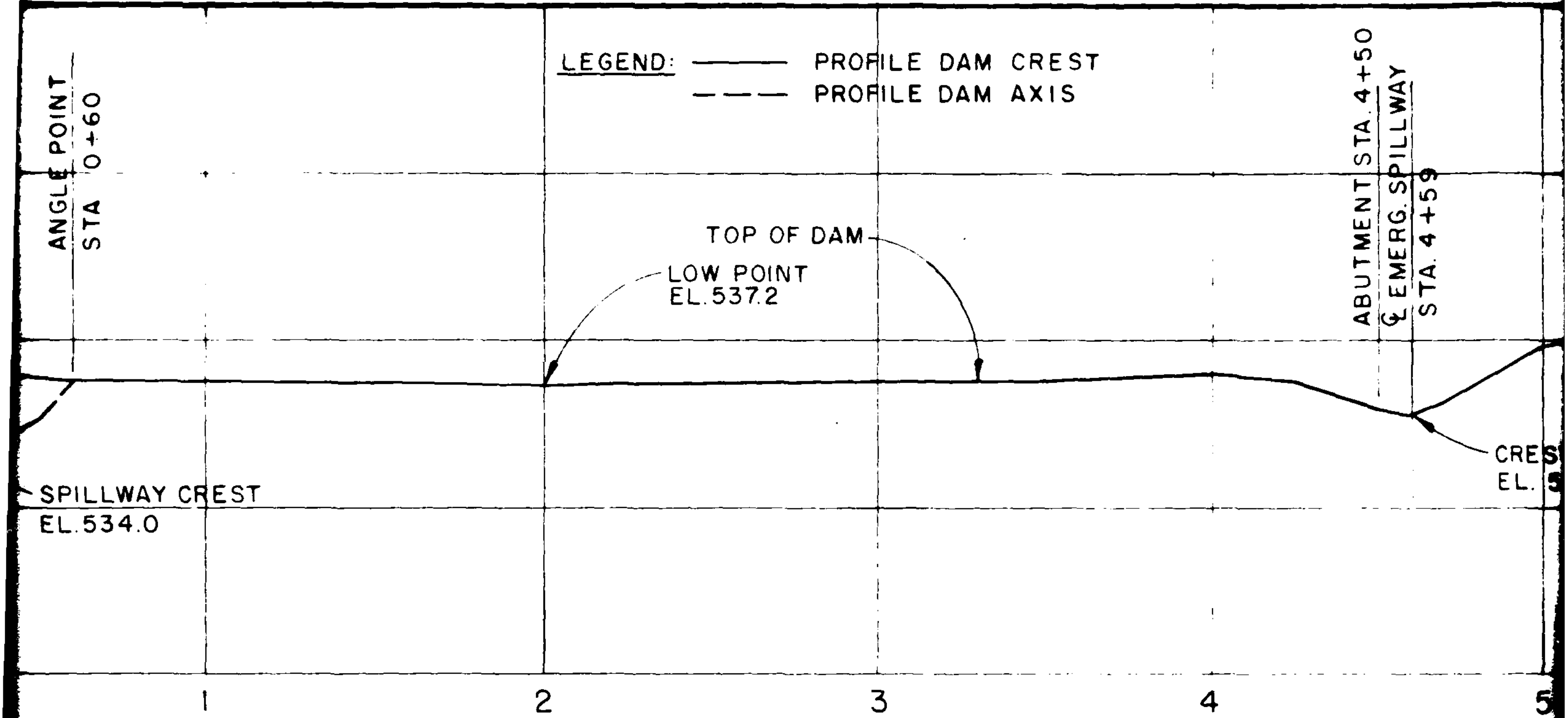
PR

SC



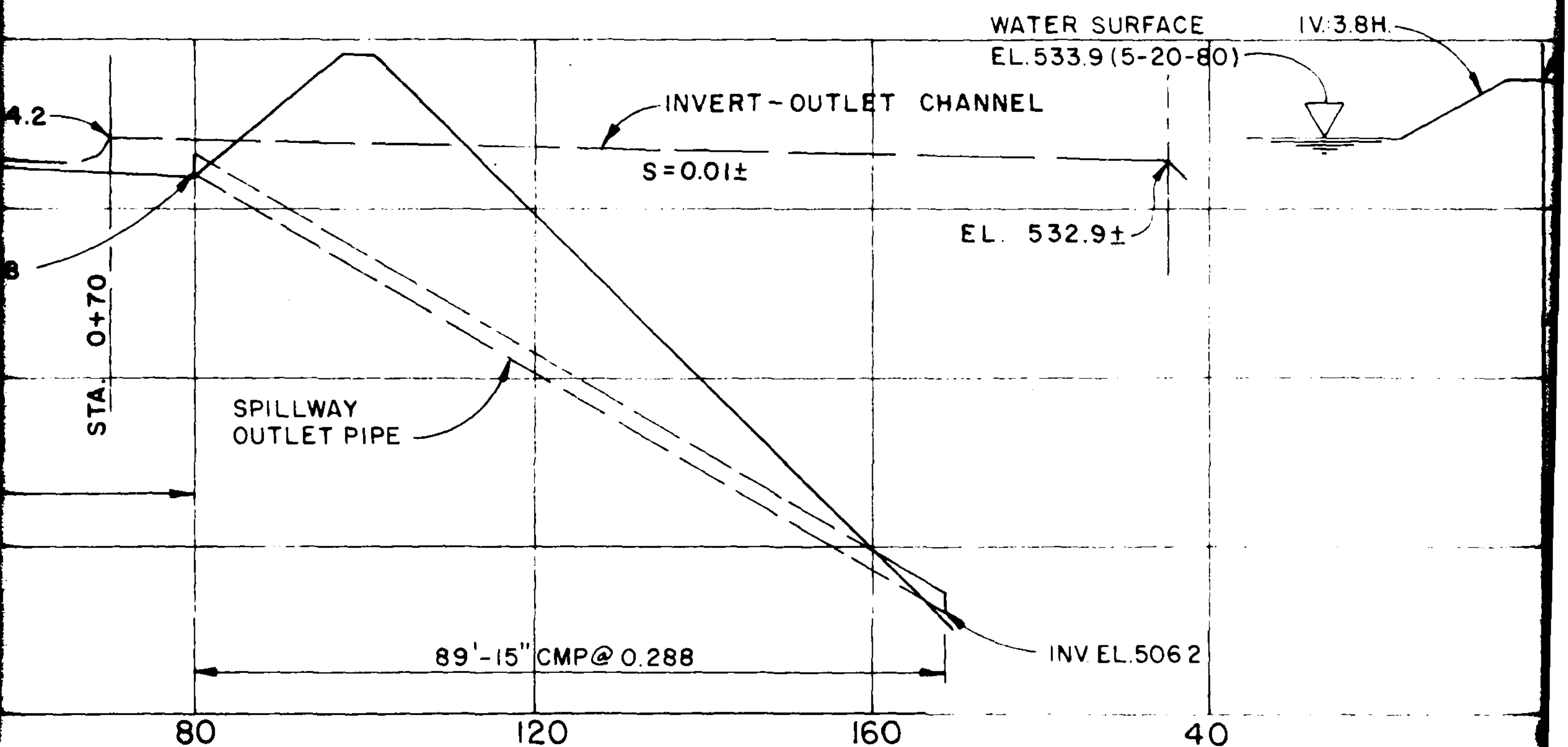
PROFILE—OUTLET PIPE & C

SCALE: 1"=10'V., 1"=20'H.



PROFILE DAM CREST

SCALE: 1"=10' V., 1"=50' H.



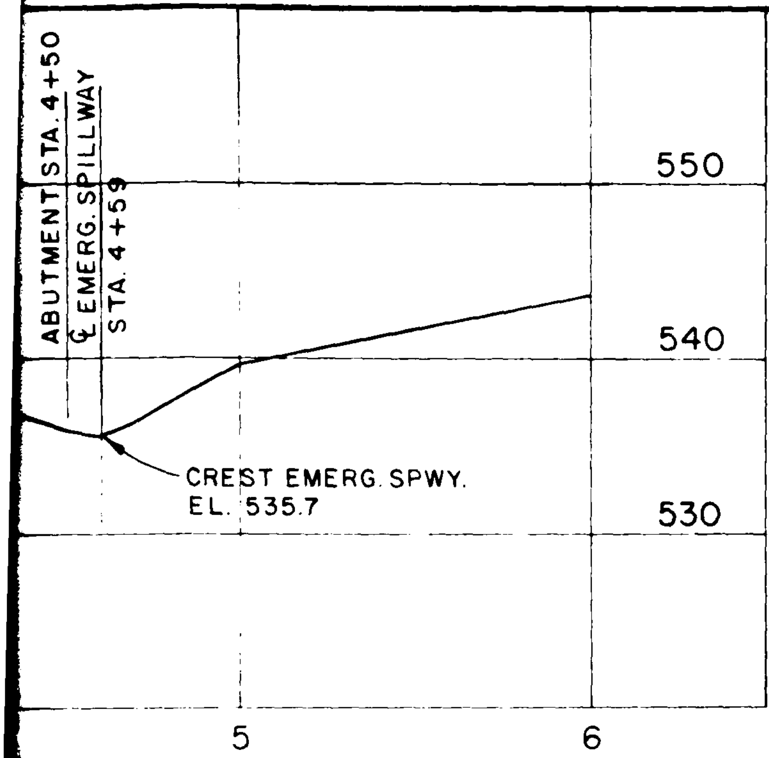
E-OUTLET PIPE & CHANNEL

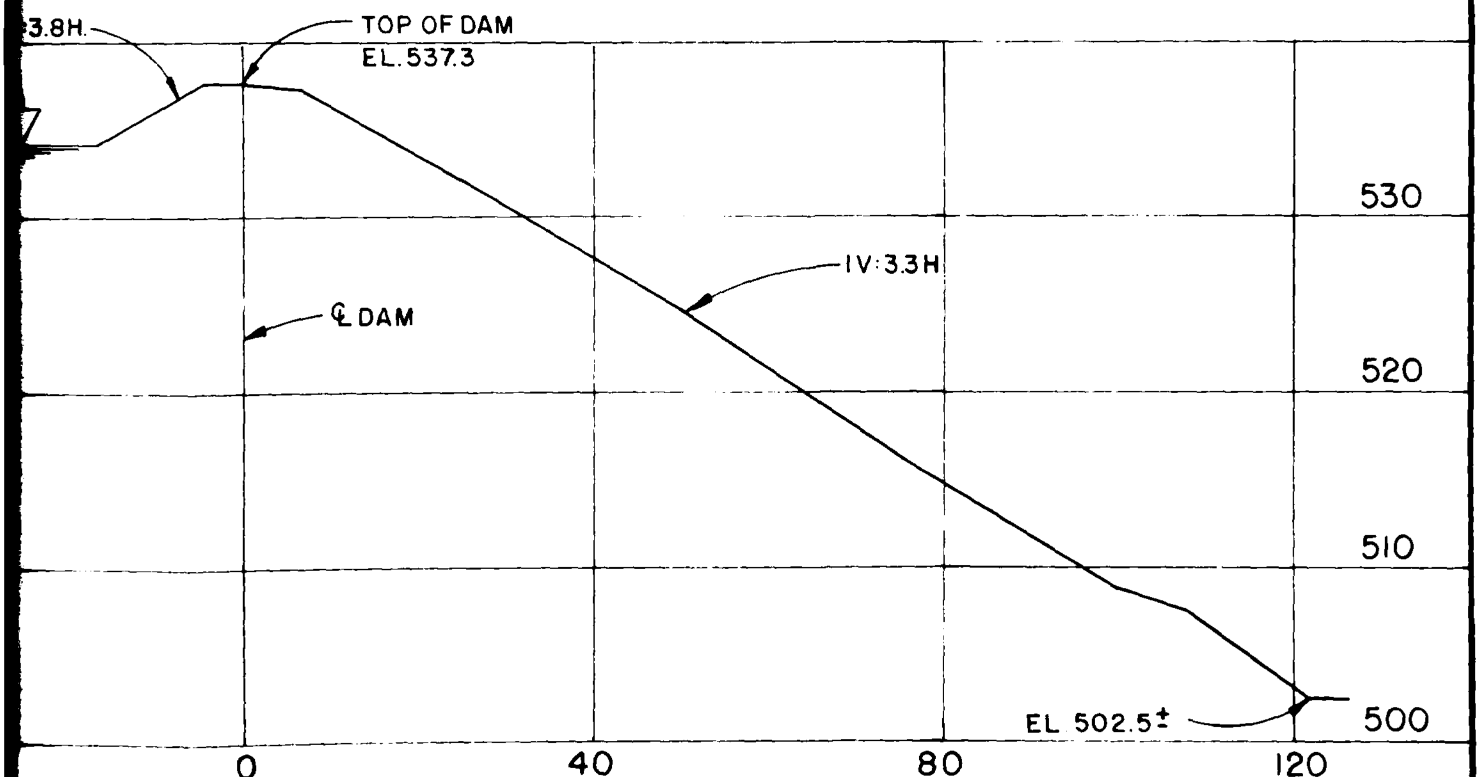
SCALE: 1"=10'V., 1"=20'H.

12

VOELKERDING LAKE
DAM PROFILE &
CROSS-SECTIONS

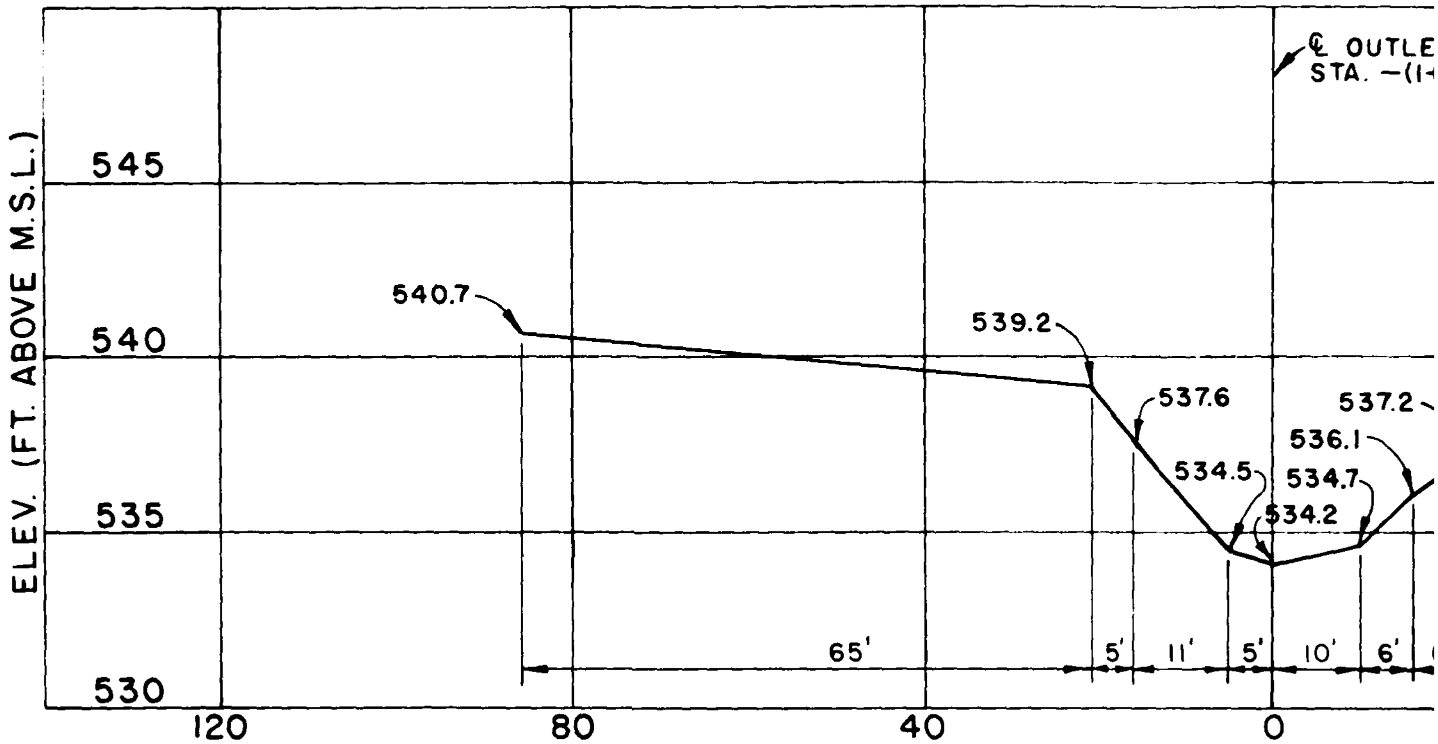
Horner & Shifrin, Inc.   July 1980





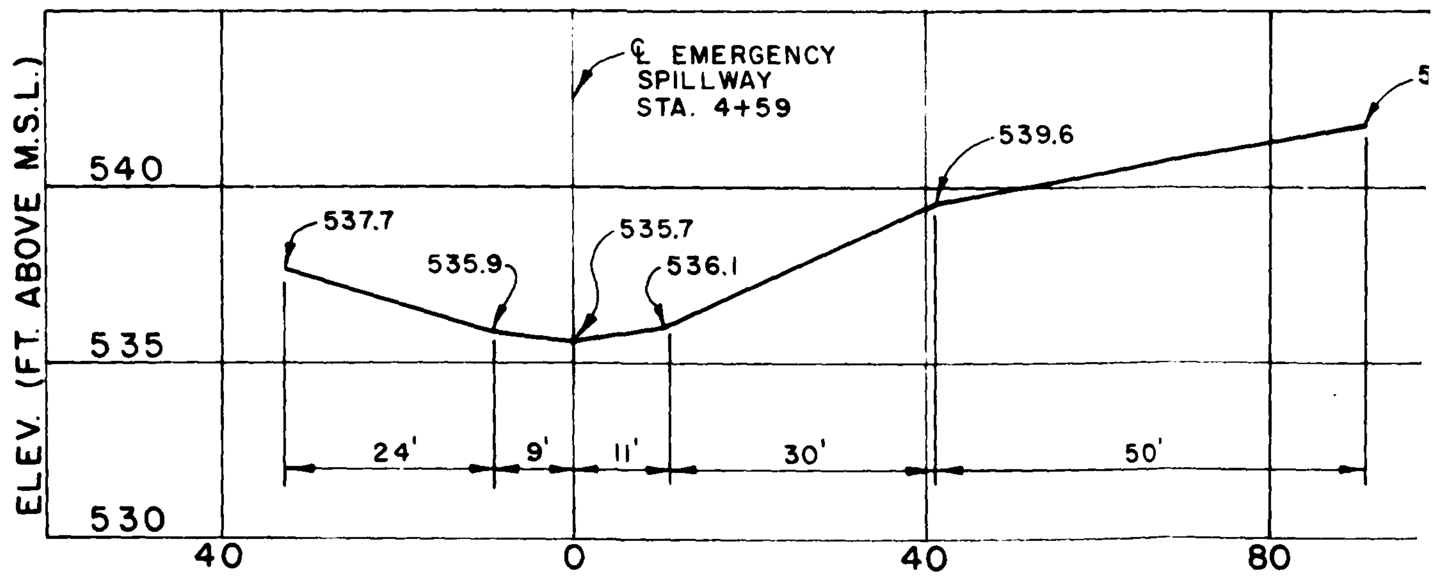
DAM CROSS-SECTION STA. 2+20
SCALE: 1" = 10' V., 1" = 20' H.

PLATE 4



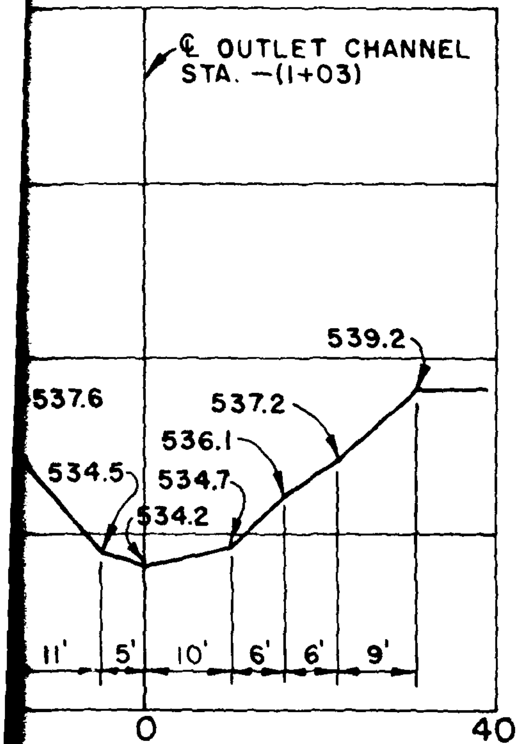
OUTLET CHANNEL CROSS-SECTION STA. 0+70

SCALE: 1"=5' V., 1"=20' H.

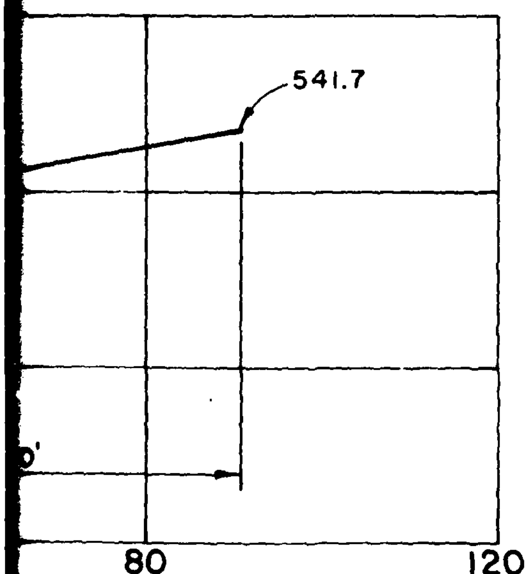


EMERGENCY SPILLWAY CROSS-SECTION — ℄ DAM

SCALE: 1"=5' V., 1"=20' H.



STA. 0+70



ION — ℄ DAM

VOELKERDING LAKE
SPILLWAY
CROSS-SECTIONS
Horner & Shifrin, Inc. Sept. 1980

[illegible] RECONNAISSANCE REPORT [illegible]

[illegible] small lake (10 - 12 acres) built [illegible] Walter Voelkerding farm in the [illegible] (Augusta [illegible]) is leaking. Since the construction of this lake [illegible] has never been full except after a 9 inch rain. At present there are at least [illegible] on the downstream toe of the dam.

[illegible] the material for the dam was borrowed [illegible] the lake confines [illegible] to Mr. Voelkerding; sands were exposed during excavation. Therefore [illegible] that [illegible] is due to water percolating through this fine [illegible] of the sands show [illegible] from the St. [illegible] sandstone formation. [illegible] in this lake could [illegible] by one or two methods. The first method would be to spray bentonite [illegible] of approximately 1 pound per square foot in the lower five acre portion [illegible]. This bentonite should be sprayed with an air distributing attachment [illegible] the nozzle should protrude at least 2 feet below the [illegible]. This method will [illegible] the bentonite [illegible]. In this [illegible] situation the [illegible] is the [illegible] over the granular [illegible]. [illegible] is [illegible] should be [illegible] than [illegible].

[illegible] alleviating the lake and [illegible] a stable [illegible] feet below the [illegible] that the water level [illegible] will increase the [illegible] water [illegible] flow through the dam. [illegible] can be built, [illegible] should be [illegible] across the [illegible] to determine the [illegible] of the fine grained water [illegible] sands that are present [illegible] the existing dozer trenches. The core for the [illegible] should then [illegible] to below this [illegible] and backfill with a good compacted clay or silty clay [illegible] silt. The height of the lower dam will have to be high enough to [illegible] at [illegible] feet free board and high enough [illegible] that the water level [illegible] 2 to 4 feet above the present [illegible].

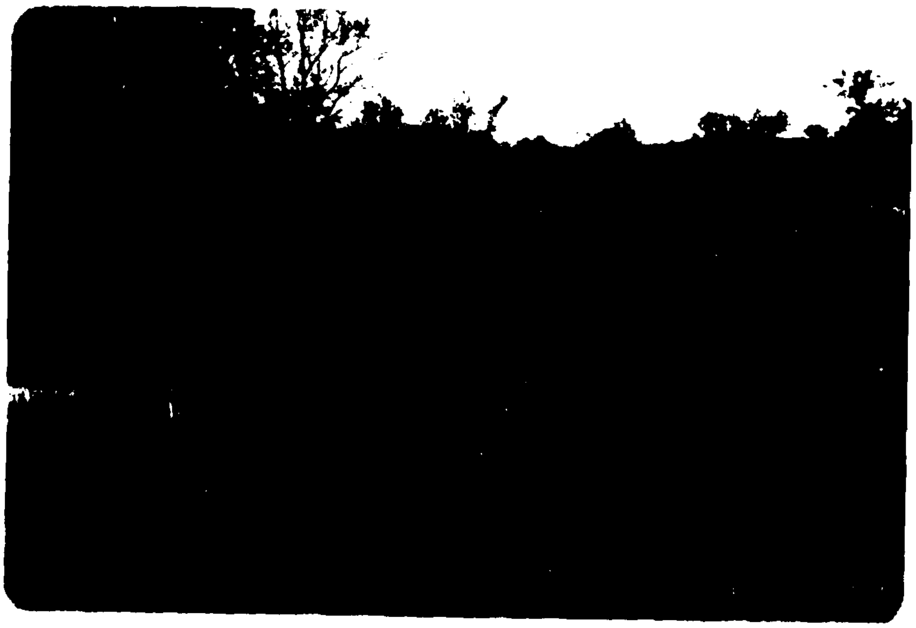
Edwin E. Lutzen
Engineering Geologist
Missouri Geological Survey
August 19, 1966

Chart 2-1

APPENDIX A

INSPECTION PHOTOGRAPHS

NO. 1: UPSTREAM FACE OF DAM

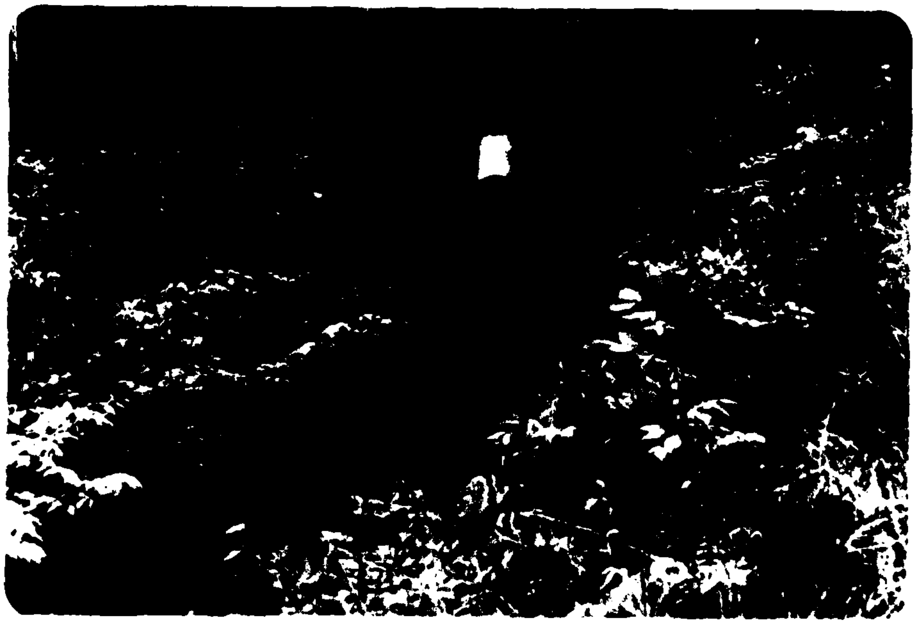


NO. 2: DOWNSTREAM FACE OF DAM

NO. 3: PRINCIPAL SPILLWAY CREST

NO. 4: PRINCIPAL SPILLWAY CHANNEL DOWNSTREAM OF CREST

NO. 5: UPSTREAM END OF SPILLWAY OUTLET PIPE



NO. 6: DOWNSTREAM END SPILLWAY OUTLET PIPE

NO. 7: PRINCIPAL SPILLWAY OUTLET CHANNEL

NO. 8: EMERGENCY SPILLWAY

NO. 9: SEEPAGE NEAR LEFT ABUTMENT

NO. 10: AREA OF SEEPAGE NEAR LEFT ABUTMENT

APPENDIX B

HYDROLOGIC AND HYDRAULIC ANALYSES

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

1. The HEC-1 Dam Safety Version (July 1978, Modified 26 February 1979) program was used to develop inflow and outflow hydrographs and dam overtopping analyses, with hydrologic inputs as follows:

a. Probable maximum precipitation (200 sq. mile, 24-hour value equals 25.2 inches) from Hydrometeorological Report No. 33. The precipitation data used in the analysis of the 1 percent (100-year flood) was provided by the St. Louis District, Corps of Engineers. Due to the fact that the watershed for this reservoir is small, the lake level was assumed to be at normal pool as a result of antecedent storms prior to occurrence of the PMF and the probabilistic storm.

b. Drainage area = 0.152 square miles = 97 acres.

c. SCS parameters:

Time of Concentration (Tc) = $\left(\frac{11.9L^3}{H}\right)^{0.385}$ = 0.093 hours

Where: T_c = Travel time of water from hydraulically most distant point of interest, hours.

L = Length of longest watercourse = 0.32 miles.

H = Elevation difference = 191 feet.

Lag time = 0.056 hours (0.60 Tc)

The time of concentration (Tc) was obtaied using Method C as described in Figure 30, "Design of Small Dams", by the United States Department of the Interior, Bureau of Reclamation, and was verified using average channel velocity estimates and watercourse lengths.

Hydrologic soil group = B (100% Winfield and Holstien series) per SCS County Soil Report

Soil type CN = 75 (AMC II, 100-yr flood condition)
= 88 (AMC III, PMF condition)

2. The principal spillway has two outlets, a 15-inch pipe outlet and a trapezoidal overflow section, both of which are located about 90 feet downstream of the dam centerline at the right abutment.

a. Inflow to the 15-inch corrugated metal pipe outlet was determined by assuming flow was over a sharp edge submerged orifice. The following equation was used: $Q = Ca\,(2gh)^{0.5}$, where "C" is a coefficient assumed to be 0.60, "a" is the area, 1.23 sf, of the orifice. "h" is the height of flow above the orifice, and "g" is acceleration due to gravity. Reference, "Handbook of Hydraulics", Fifth Edition, by King and Brater, page 4-3.

Flow through the 15-inch diameter outlet pipe was determined using Bernoulli's equation for pressure flow in pipes. Losses, including throat. entrance, pipe and exit losses totaled 6.89 velocity heads. Reference, "Handbook of Hydraulics", Fifth Edition, by King and Brater, pages 8-5 and 8-6.

Discharge quantities, determined by the methods described herein were plotted versus corresponding lake water surface elevations to determine the discharge rating curve for the spillway pipe.

b. The other spillway outlet consists of a broad-crested, irregular trapezoidal section for which conventional weir formulas do not apply. Spillway release rates for this section were determined as follows:

(1) Spillway crest section properties (areas, "a", and top width, "t") were computed for various depths, "d".

(2) It was assumed that flow over the spillway crest would occur at critical depth. Flow at critical depth Q_c was computed as

$Q_c = \left(\frac{a^3 g}{t}\right)^{0.5}$ for the various depths, "d". Corresponding

velocities (v_c) and velocity heads (H_{vc}) were determined using conventional formulas.* Reference, "Handbook of Hydraulics", Fifth Edition, by King and Brater, page 8-7.

(3) Static lake levels corresponding to the various values passing the spillway were computed as critical depths plus critical velocity heads ($d_c + H_{vc}$), and the relationship between lake level and spillway discharge was thus obtained. The procedure neglects the minor insignifcant friction losses across the length of the spillway.

3. The emergency spillway section, located at the left abutment, consists of a broad-crested irregular trapezoidal section for which conventional weir formulas do not apply. Spillway release rates for the emergency spillway section were determined as described above for the trapezoidal section at the principal spillway.

4. The discharges for the principal and emergency spillways (including the 15-inch pipe outlet) were summated for equal elevations and entered on the Y4 and Y5 cards.

5. The profile of the dam crest is irregular and flow over the dam cannot be determined by application of conventional weir formulas. Crest length and elevation data for the dam crest proper were entered into the HEC-1 Program on the $L and $V cards. The program assumes that flow over the dam crest section occurs at critical depth and computes internally the flow over the dam crest and adds this flow to the flow passing the spillways as entered on the Y4 and Y5 cards.

* $v_c = \frac{Qc}{a}$; $Hvc = \frac{v^2}{2g}$

```
A1        ANALYSIS OF [illegible]                    [illegible] OF THE
A2        [illegible]                          [illegible] OF [illegible] DAM
A3        RATIOS OF [illegible]
[illegible]
[illegible]
[illegible]       1        4
[illegible]  0.50     0.5[illegible]
[illegible]        0  INFLOW                                                   1
[illegible]       INFLOW HYDROGRAPH
[illegible]       1        [illegible]  0.[illegible]                    1.                      1
[illegible]       0     25.[illegible]     10[illegible]
[illegible]                                                                    1        [illegible]
[illegible]            0.[illegible]
[illegible]  -1.0     -.10       2.0
[illegible]       1     DAM                                                    1
[illegible]       RESERVOIR ROUTING BY [illegible]
[illegible]
Y1       1                                                        144.[illegible]      -1
Y4 534.0    534.2    53[illegible]    53[illegible]    [illegible]    [illegible].5    5[illegible].0    53[illegible].5    538.0    5[illegible].5
Y4 53[illegible]    53[illegible].5    540.0    5[illegible].5    [illegible]    [illegible]    5[illegible].0
Y5       0        4     2[illegible]    [illegible]    1[illegible]    [illegible]    [illegible]    [illegible]    854    [illegible]175
[illegible] 1[illegible]    1[illegible]    1[illegible]    [illegible]    [illegible]    [illegible]    [illegible]
[illegible]      0     1[illegible]    [illegible]    [illegible]    [illegible]
[illegible] 5[illegible]     534      5[illegible]    [illegible]
[illegible] 5[illegible]
[illegible] 5[illegible]
[illegible]    [illegible]    [illegible]    [illegible]    [illegible]    [illegible]    [illegible]    498
[illegible] 5[illegible]    5[illegible]    5[illegible]    5[illegible]    [illegible]    [illegible]    [illegible]    544.0
[illegible]
```

```
A1        ANALYSIS OF DAM OVERTOPPING USING 100 YR FLOOD
A2       HYDROLOGIC HYDRAULIC ANALYSIS OF SAFETY OF VOELLERDING LAKE DAM
A3        100 YR FLOOD ROUTED THROUGH RESERVOIR
B     288         0         5                                                4
B1      5
J       1         1         1
J1   1.00
K       0   INFLOW                                       1         1
K1        INFLOW HYDROGRAPH
M       0         2      0.15                  1.0                           1
O     288     7.004
O1   .006      .006      .006      .006      .006      .006      .006      .006      .006      .006
O1   .006      .006      .006      .006      [illegible] .006    .006      .006      .006      .006
O1   [illegible] .006    .006      .006      .006      .006      .006      .006      .006      .006
O1   .006      .006      .006      .006      [illegible] .006    .006      .006      .006      .006
O1   .006      .006      .006      .006      [illegible] .006    .006      .006      .006      .006
O1   .006      .006      .006      .006      [illegible] .006    .006      .006      .006      .006
O1   .006      [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] .006 [illegible]
O1   [illegible] [illegible] .014  .014      .014      .014      .014      .014      .014      .014
O1   .014      .014      .014      .014      .014      .014      .014      .014      .014      .014
O1   .014      .014      .014      .014      .014      .014      .014      .014      .014      .014
O1   .014      .014      .014      [illegible] .014    .014      .014      .014      .024      .024
O1   .024      .024      [illegible] [illegible] [illegible] [illegible] .024 .024    .024      .024
O1   .024      .024      [illegible] [illegible] [illegible] [illegible] .029 .029    .029      .029
O1   [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] .060 .129 .129
O1   .130      .127      [illegible] [illegible] [illegible] [illegible] .127 .130    .130      .129
O1   .060      .060      [illegible] [illegible] [illegible] .060 .029     .029      .029      [illegible]
O1   .029      [illegible] .024    [illegible] [illegible] .024 .024       .024      .024      .024
O1   .024      .024      .024      [illegible] .024    [illegible] .024    .024      .024      .024
O1   .014      .014      .014      .014      .014      .014      .014      .014      .014      .014
O1   .014      .014      .014      .014      [illegible] .014    .014      .014      .014      .014
O1   .014      .014      [illegible] [illegible] [illegible] [illegible] .014 .014    .014      .014
O1   .014      .014      .014      .014      [illegible] .014    .006      .006      .006      .006
```

```
01  .006   .006   .006   .006   [illegible]  .006   .006   .006   .006   .006
01  .006   [illegible]  [illegible]  [illegible]  [illegible]  .006   .006   .006   .006   .006
01  .006   [illegible]  [illegible]  [illegible]  [illegible]  .006   .006   .006   .006   .006
01  .006   .006   .006   [illegible]  .006   .006   .006   .006   .006   .006
01  .006   .006   .006   [illegible]  [illegible]  .006   .006   .006   .006   .006
01  .006   .006   [illegible]  .006   [illegible]  .006   .006   .006   .006   .006
01  .006   .006   .006   .006   .006   .006   .006   .006
T                                                   -1     70
[illegible]       0.056
[illegible]   1.0    .10    2.0
[illegible]   1      DAM                                    1
[illegible]      RESERVOIR ROUTING BY MODIFIED PULS
Y                                   1      1
Y1    1                                            134.00     1
Y4  534.0  534.2  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible].5  578.0  580.5
Y4  [illegible]  536.5  [illegible]  [illegible]  [illegible]  541.0  542.0
Y5      0      4  [illegible].5  [illegible]  [illegible]  222    370    570    854   1175
Y5   1544   [illegible]  [illegible]  [illegible]  [illegible]  4[illegible]  5183
SA      0   10.0  [illegible]  [illegible]  [illegible]
SE  532.5   534  [illegible]  [illegible]  [illegible]
SS  534.0
SD  [illegible]
SL      0  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  490
SV  537.0  537.5  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  [illegible]  544.0
K    [illegible]
```

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF VOELKERDING LAKE DAM
RATIOS OF PMF ROUTED THROUGH RESERVOIR

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	5	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 4 LRTIO= 1
RTIOS= .50 .55 .60 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
INFLOW	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.15	0.00	.15	1.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.20	102.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-88.00	0.00	0.00

CURVE NO = -88.00 WETNESS = -1.00 EFFECT CN = 88.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .06

RECESSION DATA
STRTQ= -1.00 QRCSN= -.10 RTIOR= [illegible]

TIME INCREMENT TOO LARGE--(NHQ IS GT LAG/2)

UNIT HYDROGRAPH 5 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .06 VOL= 1.00
721. 342. 86. 21. 6.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
[illegible]	.05	1	.01	.00	.01	0.	1.01	12.05	145	[illegible]	.21	[illegible]	[illegible]
1.01	.10	2	.01	0.00	.01	0.	1.01	12.10	146	[illegible]	[illegible]	.01	[illegible]
1.01	.15	3	.01	0.00	.01	0.	1.01	12.15	147	[illegible]	.21	[illegible]	[illegible]
[illegible]	.20	4	.01	0.00	.01	0.	1.01	12.20	148	.21	[illegible]	[illegible]	242.
[illegible]	.25	5	.01	0.00	.01	0.	1.01	12.25	149	[illegible]	.21	[illegible]	244.
1.01	.30	6	.01	0.00	.01	0.	1.01	12.30	150	[illegible]	[illegible]	[illegible]	244.
1.01	.35	7	.01	0.00	.01	0.	1.01	12.35	151	[illegible]	.21	[illegible]	245.
[illegible]	.40	8	.01	0.00	.01	0.	1.01	12.4	152	.21	.21	[illegible]	245.
[illegible]	.45	9	.01	0.00	.01	0.	1.01	12.45	153	[illegible]	.21	[illegible]	245.
[illegible]	.50	10	.01	0.00	.01	0.	1.01	12.50	154	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	.55	11	.01	0.00	.01	0.	[illegible]	12.55	155	[illegible]	.21	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	.01	0.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	15	[illegible]	[illegible]	.01	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	16	.01	[illegible]	.01	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1.25	17	[illegible]	[illegible]	[illegible]	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1.35	19	[illegible]	[illegible]	.01	[illegible]	[illegible]	13.35	[illegible]	[illegible]	.25	[illegible]	[illegible]
[illegible]	[illegible]	20	[illegible]	.00	.01	0.	1.01	13.40	[illegible]	[illegible]	.25	[illegible]	[illegible]
[illegible]	1.45	21	.01	.00	.01	0.	[illegible]	13.45	[illegible]	[illegible]	.25	[illegible]	[illegible]
1.01	1.50	22	.01	.00	.01	1.	1.01	13.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1.01	1.55	23	.01	.00	.01	1.	1.01	13.55	167	[illegible]	.25	.00	[illegible]
[illegible]	2.00	24	.01	.00	.01	1.	[illegible]	14.00	168	[illegible]	.25	.00	[illegible]
1.01	2.05	25	.01	.00	.01	1.	1.01	14.05	169	[illegible]	.32	.00	344.
1.01	2.10	26	.01	.00	.01	2.	1.01	14.10	170	[illegible]	.32	[illegible]	[illegible]
1.01	2.15	27	.01	.00	.01	2.	1.01	14.15	171	.32	.32	.00	[illegible]
1.01	2.20	28	.01	.00	.01	2.	1.01	14.20	172	.32	.32	.00	374.
[illegible]	2.25	29	.01	.00	.01	3.	1.01	14.25	173	[illegible]	.32	[illegible]	374.
1.01	2.30	30	.01	.00	.01	3.	1.01	14.30	174	.32	.32	.00	374.
1.01	2.35	31	.01	.00	.01	3.	1.01	14.35	175	.32	.32	.00	375.
1.01	2.40	32	.01	.00	.01	3.	1.01	14.40	176	.32	.32	.00	375.
1.01	2.45	33	.01	.00	.01	4.	1.01	14.45	177	.32	.32	.00	375.
1.01	2.50	34	.01	.00	.01	4.	1.01	14.50	178	.32	.32	.00	375.

END-OF-PERIOD FLOW (Cont'd)

1.01	2.55	35	[illegible]	.00	.01	4.	1.01	14.55	179	.32	.32	.00	375.
1.01	3.00	36	.01	.00	.01	4.	1.01	15.00	180	.32	.32	.00	375.
1.01	3.05	37	.01	.00	.01	4.	1.01	15.05	181	.20	.19	.00	285.
1.01	3.10	38	.01	.00	.01	5.	1.01	15.10	182	.39	.39	.00	382.
1.01	3.15	39	.01	.00	.01	5.	1.01	15.15	183	.39	.39	.00	438.
1.01	3.20	40	.01	.00	.01	5.	1.01	15.20	184	.59	.58	.00	592.
1.01	3.25	41	.01	.00	.01	5.	1.01	15.25	185	[illegible]	[illegible]	[illegible]	[illegible]
1.01	3.30	42	.01	[illegible]	.01	5.	1.01	15.30	186	[illegible]	1.65	.01	1405.
1.01	3.35	43	.01	[illegible]	.01	6.	1.01	15.35	187	[illegible]	2.72	.01	[illegible]
1.01	3.40	44	.01	[illegible]	.01	6.	1.01	15.40	188	1.67	[illegible]	[illegible]	[illegible]
1.01	3.45	45	.01	.01	.01	6.	1.01	15.45	189	.68	[illegible]	[illegible]	[illegible]
[illegible]	3.50	46	.01	.01	.01	6.	1.01	15.50	[illegible]	[illegible]	.53	[illegible]	[illegible]
[illegible]	3.55	47	.01	.01	.01	6.	1.01	15.55	191	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	48	.01	.01	.01	6.	1.01	[illegible]	192	[illegible]	.28	[illegible]	[illegible]
[illegible]	4.05	49	.01	.01	.01	7.	1.01	16.05	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	.01	.01	7.	1.01	16.10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	.01	[illegible]	7.	1.01	16.15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	.01	.01	7.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	4.25	[illegible]	[illegible]	[illegible]	.01	[illegible]	1.01	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	54	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.01	[illegible]	[illegible]	16.35	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16.40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	4.45	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16.45	201	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.24	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.01	[illegible]	1.01	17.10	[illegible]	.24	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.01	[illegible]	1.01	17.15	[illegible]	[illegible]	.24	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	.01	[illegible]	[illegible]	1.01	17.20	[illegible]	.24	.24	[illegible]	[illegible]
[illegible]	[illegible]	65	[illegible]	[illegible]	.01	[illegible]	[illegible]	17.25	[illegible]	.24	.24	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.24	.24	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17.35	211	.24	.24	[illegible]	[illegible]
[illegible]	[illegible]	68	[illegible]	.01	.01	[illegible]	1.01	17.40	212	.24	.24	[illegible]	[illegible]
[illegible]	5.45	[illegible]	.01	.01	.01	[illegible]	1.01	17.45	213	.24	.24	[illegible]	[illegible]
[illegible]	5.50	[illegible]	.01	.01	.01	9.	1.01	17.50	214	.24	.24	[illegible]	[illegible]
[illegible]	5.55	[illegible]	.01	.01	.01	9.	1.01	17.55	215	.24	.24	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	.01	.01	.01	9.	1.01	18.00	216	.24	.24	[illegible]	[illegible]
1.01	[illegible]	73	[illegible]	.04	.03	30.	1.01	18.05	217	.02	[illegible]	[illegible]	[illegible]
1.01	[illegible]	[illegible]	[illegible]	.04	.02	41.	1.01	18.10	218	.02	.02	.00	[illegible]
1.01	6.15	75	[illegible]	.04	.02	45.	1.01	18.15	219	.02	.02	[illegible]	[illegible]
1.01	[illegible]	[illegible]	.06	.04	.02	46.	1.01	18.20	220	.02	[illegible]	.00	[illegible]
1.01	6.25	[illegible]	[illegible]	.04	.02	49.	1.01	18.25	221	[illegible]	[illegible]	.00	[illegible]
[illegible]	6.30	78	[illegible]	.04	.02	[illegible]	1.01	18.30	222	.02	.02	[illegible]	173.

END-OF-PERIOD FLOW (Cont'd)

1.01	6.35	79	.06	.04	.02	52.	1.01	18.35	223	.02	.02	.00	161.
1.01	6.40	80	.06	.05	.02	53.	1.01	18.40	224	.02	.02	.00	151.
1.01	6.45	81	.06	.05	.02	54.	1.01	18.45	225	.02	.02	.00	141.
1.01	6.50	82	.06	.05	.02	55.	1.01	18.50	226	.02	.02	.00	131.
1.01	6.55	83	.06	.05	.02	56.	1.01	18.55	227	.02	.02	.00	122.
1.01	7.00	84	.06	.05	.01	56.	1.01	19.00	228	.02	.02	.00	114.
1.01	7.05	85	.06	.05	.01	57.	1.01	19.05	229	.02	.02	.00	107.
1.01	7.10	86	.06	.05	.01	58.	1.01	19.10	230	.02	.02	.00	[illegible]
1.01	7.15	87	.06	.05	.01	59.	1.01	19.15	231	.02	.02	.00	[illegible]
1.01	7.20	88	.06	.05	.01	59.	1.01	19.20	232	.02	.02	.00	[illegible]
1.01	7.25	89	.06	.05	.01	60.	1.01	19.25	233	.02	.02	[illegible]	[illegible]
1.01	7.30	90	.06	.05	.01	60.	1.01	19.30	234	.02	.02	.00	77.
1.01	7.35	91	.06	.05	.01	61.	1.01	19.35	235	.02	.02	.00	[illegible]
1.01	7.40	92	.06	.05	.01	61.	1.01	19.40	236	.02	.02	[illegible]	[illegible]
1.01	7.45	93	.06	.05	.01	62.	1.01	19.45	237	.02	.02	[illegible]	[illegible]
1.01	7.50	94	.06	.05	.01	62.	1.01	19.50	238	.02	.02	.00	[illegible]
1.01	7.55	95	.06	.05	.01	63.	1.01	19.55	239	.02	.02	.00	[illegible]
1.01	8.00	96	.06	.05	.01	63.	1.01	20.00	240	.02	.02	[illegible]	[illegible]
1.01	8.05	97	.06	.05	.01	64.	1.01	20.05	241	.02	.02	.00	[illegible]
1.01	8.10	[illegible]	[illegible]	.05	.01	64.	1.01	20.10	242	.02	.02	[illegible]	[illegible]
1.01	8.15	99	.06	.05	.01	64.	1.01	20.15	243	.02	.02	[illegible]	[illegible]
1.01	8.20	100	.06	.06	.01	65.	1.01	20.20	244	.02	.02	.00	[illegible]
1.01	8.25	101	.06	.06	.01	65.	1.01	20.25	245	.02	.02	.00	[illegible]
1.01	8.30	102	.06	.06	.01	65.	1.01	20.30	246	.02	.02	[illegible]	[illegible]
1.01	8.35	103	.06	.06	.01	65.	1.01	20.35	247	.02	.02	.00	[illegible]
1.01	8.40	104	.06	.06	.01	66.	1.01	20.40	248	.02	.02	.00	[illegible]
1.01	8.45	105	.06	.06	.01	66.	1.01	20.45	249	.02	.02	[illegible]	27.
1.01	8.50	106	.06	.06	.01	66.	1.01	20.50	250	.02	.02	.00	25.
1.01	8.55	107	.06	.06	.01	66.	1.01	20.55	251	.02	.02	.00	25.
1.01	9.00	108	.06	.06	.01	67.	1.01	21.00	252	.02	.02	[illegible]	25.
1.01	9.05	109	.06	.06	.01	67.	1.01	21.05	253	.02	.02	.00	25.
1.01	9.10	110	.06	.06	.01	67.	1.01	21.10	254	.02	.02	.00	25.
1.01	9.15	111	.06	.06	.01	67.	1.01	21.15	255	.02	.02	.00	25.
1.01	9.20	112	.06	.06	.01	67.	1.01	21.20	256	.02	.02	.00	25.
1.01	9.25	113	.06	.06	.01	68.	1.01	21.25	257	.02	.02	.00	25.
1.01	9.30	114	.06	.06	.01	68.	1.01	21.30	258	.02	.02	.00	25.
1.01	9.35	115	.06	.06	.01	68.	1.01	21.35	259	.02	.02	.00	25.

END-OF-PERIOD FLOW (Cont'd)

1.01	9.40	116	.06	.06	.01	68.	1.01	21.40	260	.02	.02	.00	25.
1.01	9.45	117	.06	.06	.00	68.	1.01	21.45	261	.02	.02	.00	25.
1.01	9.50	118	.06	.06	.00	68.	1.01	21.50	262	.02	.02	.00	25.
1.01	9.55	119	.06	.05	.00	69.	1.01	21.55	263	.02	.02	.00	25.
1.01	10.00	120	.06	.06	.00	69.	1.01	22.00	264	.02	.02	.00	25.
1.01	10.05	121	.06	.06	.00	69.	1.01	22.05	265	.02	.02	.00	25.
1.01	10.10	122	.06	.06	.00	69.	1.01	22.10	266	.02	.02	[illegible]	25.
1.01	10.15	123	.06	.06	.00	69.	1.01	22.15	267	.02	.02	[illegible]	25.
1.01	10.20	124	.06	.06	.00	69.	1.01	22.20	268	.02	.02	.00	25.
1.01	10.25	125	.06	.06	.00	69.	1.01	22.25	269	.02	.02	[illegible]	25.
1.01	10.30	126	.06	.06	.00	69.	1.01	22.30	270	.02	.02	.00	25.
1.01	10.35	127	.06	.06	.00	70.	1.01	22.35	271	.02	.02	[illegible]	25.
1.01	10.40	128	.06	.06	.00	70.	1.01	22.40	272	.02	.02	[illegible]	25.
1.01	10.45	129	.06	.06	.00	70.	1.01	22.45	273	.02	.02	[illegible]	25.
1.01	10.50	130	.06	.06	.00	70.	1.01	22.50	274	.02	.02	[illegible]	25.
1.01	10.55	131	.06	.06	.00	70.	1.01	22.55	275	.02	.02	[illegible]	25.
1.01	11.00	132	.06	.06	.00	70.	1.01	23.00	276	.02	.02	[illegible]	25.
1.01	11.05	133	.06	.06	[illegible]	70.	1.01	23.05	277	.02	.02	[illegible]	25.
1.01	11.10	134	.06	.06	.00	70.	1.01	23.10	278	.02	.02	.00	25.
1.01	11.15	135	.06	.06	.00	70.	1.01	23.15	279	.02	.02	[illegible]	25.
1.01	11.20	136	[illegible]	.06	.00	70.	1.01	23.20	280	.02	.02	[illegible]	25.
1.01	11.25	137	[illegible]	[illegible]	.00	[illegible]	1.01	23.25	281	.02	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	71.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1.01	11.35	[illegible]	[illegible]	[illegible]	.00	71.	1.01	23.35	283	.02	[illegible]	[illegible]	25.
1.01	11.4	14	.06	[illegible]	[illegible]	71.	1.01	23.40	284	.02	[illegible]	[illegible]	25.
1.01	11.45	141	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	23.45	285	[illegible]	[illegible]	[illegible]	[illegible]
1.01	11.50	142	.06	.06	.00	71.	1.01	23.50	286	.02	.02	.00	25.
1.01	11.55	143	.06	.06	.00	71.	1.01	23.55	287	.02	.02	.00	25.
1.01	12.00	144	.06	.06	[illegible]	71.	1.02	0.00	288	.02	.02	.00	25.

SUM 32.76 31.18 1.58 [illegible]
(832.)(792.)(40.)(1165.0[illegible])

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	2603.	416.	135.	135.	32598.
CMS	74.	12.	4.	4.	1104.
INCHES		25.45	33.15	33.15	33.15
MM		646.47	841.97	841.97	841.97
AC-FT		206.	269.	269.	269.
THOUS CU M		254.	331.	331.	331.

SURFACE AREA=	[illegible]	[illegible]	[illegible]	[illegible]	44.
CAPACITY=	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ELEVATION=	[illegible]	[illegible]	[illegible]	[illegible]	560.

SUMMARY OF DAM SAFETY ANALYSIS

PMF

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	534.00	534.00	[illegible]
STORAGE	145.	145.	200.
OUTFLOW	0.	0.	[illegible]

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
[illegible]	[illegible]	0.00	[illegible]	[illegible]	0.00	15.83	0.00
.55	537.20	.00	200.	45[illegible].	.[illegible]	15.83	0.00
.60	537.35	.15	[illegible]	[illegible]	.[illegible]	15.83	0.00
1.00	538.06	.86	21[illegible].	14[illegible].	1.17	15.75	0.00

SUMMARY OF DAM SAFETY ANALYSIS

100-YR FLOOD

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	[illegible]	534.00	[illegible]
STORAGE	145.	[illegible]	[illegible]
OUTFLOW	0.	0.	[illegible]

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]1.	0.00	[illegible].17	0.00

DATE
ILME